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NEW YORK, SEPTEMBER, 1887.

THE British Secretary of State for War has issued a memorandum to the effect that any official of the department, whether civil or military, holding stock in any firm or company which transacts business with the department is thereby disqualified from retaining his post.

If the above rule were applied to railroad officials in this country, there would be a great thinning out on some of our lines, especially in the higher ranks.

THE French Railroad Jubilee, about which a great deal was said some months ago, is a flat failure, if correspondents are to be believed. It was apparent that this would be the case when the great railroad companies of France refused their support. The fact is that no project of this kind can succeed in France without official support, and in this case it was altogether lacking. The reasons which led the railroad companies to refuse their support were sufficient and were fairly stated in a letter which was published at the time.

AN article on the use of electricity to increase adhesion and tractive power of motors, which is published in another column, indicates a line of investigation which may be productive of good results, although it is hardly likely that it will develop all that the author claims for it. His view of the question is, undoubtedly, far too sanguine; but there is enongh foundation for his claims to warrant further investigation.

In this connection it may be of some interest to note that experiments in the use of electricity for increasing adhesion were made on the Central Railroad of New Jersey nearly 30 years ago, about 1858 or 1859. Two freight engines on that road were fitted with batteries for the purpose of magnetizing the tires and so increasing the adhesion. The experiment was not long continued, however, and it does not appear that any good results were obtained; at any rate the use of the apparatus was not continued or extended. Possibly it was defective in its nature and very different from anything that would be applied now.

THE National Electric Light Association at its Boston meeting approved a bill which is to be presented to Congress at its next session, and which provides for the appointment of a commission to investigate the patent laws of this and other countries, and to report what changes seem to be needed in the present law.

That some changes are needed cannot be denied, and a properly constituted commission might do much toward the improvement of the patent laws. Its report might also well include a statement of such changes and additions as are needed to enable the Patent Office to dispose of its work with greater promptness than is now possible.

THE full extent and value of the iron-ore deposits of the Lake Superior have not been fully known or appreciated until recently. The Marquette and Menominee districts have, until within three years past, fully supplied the demand and were the only part of the region that was productive or even fully explored. Three years ago a company with abundant means began to work the extensive deposits known to exist around Vermillion Lake, some 70 miles north of Lake Superior in Minnesota, and about the same time others began to explore the Gogebic and Penokee ranges in Wisconsin, where iron ore was known to exist, although no one apparently had any definite idea of the extent or value of the deposits. These explorations and the building of new railroads through the region have resulted in an exceedingly rapid development of those ranges, where a large number of mines have already been opened and are making large shipments.

The peculiar character of the ores and the facilities for lake shipment with only a short railroad haul, making it possible to deliver ore to furnaces over a large extent of country at low rates of freight, give these deposits great value. The present indications are that they are of a nature that will permit of working for many years without exhaustion, so that a new and permanent source of supply has been secured.

THE New York meeting of the American Association for the Advancement of Science, a report of which will be found in another column, was a very successful one, whether it is considered from the point of attendance, of the variety of subjects considered or of the value of the papers presented. In so large a body and when so large a number of papers is presented some sifting process is always necessary; but at this meeting not many papers were rejected, and many of those read were of permanent value.

As was natural, much interest centered in Mr. Edison's paper, a brief abstract of which is given elsewhere. A large number were attracted by the papers on the Nicaragua Canal, and many others were interested in the papers and discussions in the Economic Section. As a whole the meeting was an excellent one; but it was unfortunately one of those which defy the limits of a necessarily condensed report.

One of the drawbacks of so large an association is that the necessary routine proceedings and the reading of papers occupy so much time as to leave far too little for

discussion. But discussion and conversation are or should be the best means of producing that mental friction and promoting the mutual acquaintance which are the chief benefits of such meetings as those of this association. Some way of giving increased time for discussion is very desirable. It would hardly be possible to lengthen the time of the meetings, and a limitation of the number of papers to be read in each section would probably be the easiest way.

NOWHERE has the old form of low-pressure beam-engine been more closely adhered to than in the numerous steamboats employed on the Hudson River and Long Island Sound. Substantially the same form of engine has been in use for many years, and the only changes made have been improvements in details and a slight increase in the working pressure carried in the boilers. Two notable exceptions are, however, to be made in two new boats of great size now building for the Stonington and the Fall River lines on Long Island Sound. In both of these boats higher boiler pressure and compound engines are to be introduced, and the approved modern practice in marine engineering will find place.

The Stonington Line boat is to have compound oscillating engine, acting directly on the main shaft; while in the steamer for the Fall River Line the beam engine will be adhered to, the compound principle and higher boiler pressure being adopted. Both will be paddle-wheel boats, and in both the feathering wheel will be adopted.

The continued adherence to the old type of engine is somewhat surprising, in view of the changes made elsewhere. The only exception to the rule heretofore has been in the building of two or three propellers of considerable size which have been for a year or two past in use on the lower Hudson, and which have proved themselves not only economical, but among the fastest boats on the river.

It is to be noted that the two new Sound boats mentioned above are to be of great size, approaching the larger ocean steamers in their dimensions and exceeding them in their passenger accomodations. For one of them, the *Puritan* for the Fall River Line, it is claimed that she will be the largest steamboat for inland waters in the world.

THE Navy Department is advancing quietly but steadily in the work of reconstructing the Navy on modern principles. Contracts for three new cruisers and two gunboats were let in August, and the plans for the new armored battle-ship and cruiser are nearly ready, so that contracts for those vessels will soon be let. Plans for the expenditure of the sum appropriated by Congress for floating batteries for harbor defense, are to be considered by a board of naval constructors and officers.

In the meantime the Department is evidently determined that vessels of old patterns and inferior construction shall not be retained any longer than is absolutely necessary. In this line are several recent decisions against repairing old vessels which would need the expenditure of considerable amounts to keep them longer in service.

In this connection it is well to note that it is not to be expected that an entirely new navy can be built and equipped without some mistakes. In England, where far more attention has been paid to fighting ships and ordnance, and where the naval expenditures are far greater than here, there is constant and severe criticism of new ships and guns, and there is abundant material for such criticism, not in mere differences of opinion, but in actual mistakes and blunders of the Admiralty and its officers.

Naval science is still largely experimental in its nature, and will necessarily continue to be so. At present we are in a state of transition, and it is impossible to say what may be the result.

AT present there seems to be, among the best English and European authorities, a tendency to return to the use of lighter and swifter vessels, and to argue that they will, after all, be of the greatest use in actual warfare. This is a reaction from the tendency of the past ten years to build armored vessels of enormous size and weight, carrying guns of corresponding size. These huge vessels have not done what was expected of them by their designers, and have proved in several cases unwieldy and hard to handle, while high speed was not expected of them.

It is now claimed that ships of this class, while exceedingly costly to build and operate, are also peculiarly open to attack from torpedo-boats. They are not adapted for cruising and are simply huge fighting machines, and in time of war it might be very difficult to put them where they were needed. In most of these ships everything has been sacrificed to fighting qualities, and now, it is charged by their opponents, they cannot even fight.

There seems to be some reason in these arguments, although it is probable that they are carried to an extreme. The big armored ship has its place, but it is probably a very limited one, while the lighter vessel is capable of a variety of uses, is an excellent cruiser and may be, properly handled, a very efficient fighter.

THE friends of the Nicaragua Interoceanic Canal are making a strong effort to secure public favor for their project. Mr. Menocal, who has for years been prominent among the advocates of this line, says that the preliminary payment upon the concession has been made, and that actual work on the canal has been begun.

The arguments in favor of this line of connection between the Atlantic and Pacific Oceans are certainly strong ones. While the distance from ocean to ocean is nearly four times as great as at Panama, the actual length of canal to be excavated is no greater, and the work is, on the whole, less difficult. The work on the improvement of the San Juan River presents no obstacles which money and engineering skill cannot readily overcome, and for the whole route there is the great advantage of a climate which, though tropical, is very healthy in comparison with that of Panama. The chief objection urged against the Nicaragua route is the number of locks which will be required and the greater time which the increased length of river and canal navigation will require. The distance from ocean to ocean by this line will be about 170 miles.

Should both the Nicaragua and the Panama canals be built, it is very doubtful whether either would be a financial success. If all the commerce which is likely to seek the transit were concentrated in the Panama Canal, it is not by any means certain that interest could be paid on the enormous cost of that work, except by charging tolls so exhorbitant in amount that they would largely reduce the business. With two canals open the tolls

would be limited by competition, and the business would be divided. In such a contest the Nicaragua route would probably fare the best, on account of its lower first cost, and, if the claims of its advocates are correct, its much lower expenses of maintenance.

THE tests of steel to be used in the new warships will hereafeter be in charge of a board composed of Captain Phythian, Lieutenant Rodgers and Assistant Engineer Bryan, who have been detailed for that duty by the Secretary of the Navy. It is understood that this new appointment does not imply any important changes of method or any relaxation of the strictness of the tests; nor is it intended to cast any reflection on the previous conduct of the tests, which has been under the charge of Commander R. E. Evans, who is now assigned to duty on the Lighthouse Board.

THE CHATSWORTH ACCIDENT.

THE month of August was marked by a railroad accident more terrible in its destruction of life than any which has occurred in this country since the Ashtabula disaster in December, 1876. The facts are briefly as follows:

An excursion train over the Toledo, Peoria & Western road broke through a small wooden bridge near Chatsworth, Ill., which was on fire, and had been so far destroyed that its timbers could offer little or no support to the train; the accident occurred near midnight of August 10. The train consisted of two locomotives, three baggage cars, six ordinary passenger cars and six sleeping cars, and appears to have been running, on a down grade, at a speed of about 40 miles an hour. The first engine passed over, but the second one went into the ditch, and the three baggage and six passenger cars were piled on and around it in a complete wreck, so that, as an eye-witness says, three cars, or their wreck, did not occupy more than the length of a car. The wreck caught fire, but the fire was kept back by the exertions of the surviving passengers, and most of it was saved. The six sleeping cars escaped with slight damage.

The train carried some 750 passengers, and of these 85 were killed at once or fatally injured, while about 150 were less severely hurt.

The bridge itself was a small wooden pile or trestle affair over a little stream which was dry at the time. The weather had been very dry for some time, and, as a measure of precaution, the trackmen had been burning off the weeds and grass near the roadbed. It was at first reported that the fire had been purposely started, but the final decision of the coroner's jury was that the sectionmen had not been sufficiently careful in extinguishing their fires, and that the bridge probably caught fire from sparks remaining in the grass.

As nearly as could be ascertained, the engineer on the forward engine first saw the fire on the bridge when he was about 500 feet away. His engine was a freight engine and was not provided with air-brakes or with driver-brakes, and the air-brakes could only be put on from the second engine, whose driver, of course, had no outlook forward, and could only act on the signals he received.

Here, then, was a combination of several sources of danger. A heavy train was running at high speed over a road in poor condition; the train was insufficiently provided with brake-power; a wooden bridge had been thoroughly dried by long drought, and was in condition to take fire from a very small spark; and fires had been within a short time burning near the bridge. A combination of all these causes, apparently, was required to produce the accident.

The first and most obvious cause was the wooden bridge; and the immediate result of the accident has been a general outcry against wooden bridges of all kinds. Theoretically, of course, all bridges and crossings should be as solid as any other part of the roadbed, and stone or iron would be the only allowable material. Practically, in the present state of railroading in this country, this is not possible, and where stone is scarce, as on most of the prairie roads, wood must continue to be largely used, until increasing traffic and prosperity permit the substitution of a more durable and less destructible material, either stone, iron or steel. So far as strength is concerned, a wooden bridge of small size can be made sufficiently safe, and with proper care and watchfulness against fire it can carry any ordinary railroad traffic.

It is not intended by this to advocate the use of wood for permanent structures where a better material is possible. Undoubtedly, there are many wooden structures now in existence on roads which can afford to do better, and which ought not to be allowed to retain them; but for temporary use, and on new and struggling roads, the wooden bridge and culvert will continue in use for a long time to come and must be accepted as necessary.

The main cause of the disaster in this case was probably the lack of sufficient care in watching and guarding the road against just such a contingency as did arise. The coroner's decision put the blame on the section-foreman, as the nearest person in authority, but a more searching investigation may find either that he had not received proper orders, or that he had followed the example of others higher in authority in a general lax way of working, and that he founded his methods upon a general looseness of discipline, which may have existed on the line, as it does on too many others. In either case he was to blame, of course; but a considerable share of condemnation may well be shifted upon other shoulders.

The manner of running the train brings up again the vexed question of using "double-headers," about which there has been so much talk in time past. The practice is not in existence on many of the best managed roads, but there are still many superintendents who would consider it safer to run such a train with two locomotives than to run it two sections, holding that the danger of collision in the latter case would be greater than any arising from the use of the second locomotive. There may well be some doubt allowed where there is such a difference of opinion as on this point.

If the double-header question be passed over, there is still much fault to be found with the make-up of the train and with its running. The speed, if given correctly, was greater than should have been allowed under the circumstances. A train so loaded as was the one in question, especially on a road in poor condition, should have been kept well in hand, and should not have exceeded a moderate speed which would permit of a quick stop in case of danger. Had this been done, the accident might have been avoided. Again, had the first engine been provided with air-brakes, or even with driver-brakes

only, it would seem as if it might have been stopped in the 500 ft. after the fire was seen, or at any rate its speed might have been checked so far that the consequences of the derailment would have been very slight. But the engineer of the first engine could not put the brakes on the train, and the time required to give the signal, slight as it would have been, was enough to destroy the chance of escape which remained. In point of fact, there does not seem to have been any serious attempt to stop the train before the bridge was reached.

The fire which threatened the destruction of the wreck and of the injured may have caught from the bridge and may have come from the lamps in the cars. Fortunately there were no fires in the stoves, or the wreck might have been kindled so quickly that it would have been impossible to prevent its complete destruction and a terrible addition to the slaughter. Only the time of year prevented a frightful addition to the death-roll and another warning against the use of dangerous stoves and heaters.

In itself the accident was not of a very uncommon kind. Especially in the West and Southwest, where prairie fires are common and roads are generally worked with the smallest possible force, run-offs from burned bridges have been recorded more than once, to say nothing of the probably more numerous cases which were not heard of. Only the substitution of a crowded passenger train for the usual freight made the present accident one of the worst in the long and terrible list which marks the history of our railroads.

THE CYLINDER CAPACITY OF LOCOMOTIVES.

THE report which has been made on this subject by the Committee of the Master Mechanics' Association, which will be found on another page, is a very timely one, as too little attention has heretofore been given to the proportion of the cylinders to the other parts and to the weights of locomotives. The fact of the diversity of practice which exists, shows that there is a great deal of ignorance or misunderstanding of the subject somewhere, otherwise there would not be so much difference in the relative sizes of cylinders.

At first sight the subject seems a very simple one, and it appears as though all that need be done is to follow Mr. Webb's practice on the London & Northwestern Railroad, which, as he reported it to the Committee, is "to arrange the diameter of the cylinders so that the tractive power at starting, with full boiler pressure, does not exceed the adhesive power under the most favorable circumstances." This means that the cylinders should be made of such a size that we can always turn the wheels in starting. As the adhesion of a locomotive with dry sanded rails, as shown by Captain Galton's experiments, is as much as—perhaps a little over—one-third of the weight on the driving-wheels, we ought to produce a rotative effect on the wheels equal to this adhesion. The Committee take the maximum adhesion at one-fourth the weight on the driving-wheels, which appears to be too little, as cylinder capacity is needed to turn the wheels when the adhesion is at its maximum, that is with a perfectly dry rail and dry sand. The Committee also take the maximum effective cylinder pressure at 85 per cent. of the boiler pressure. Molesworth gives the effective

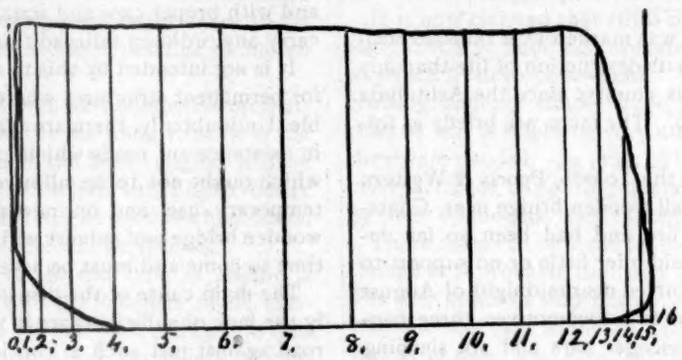


Fig. 1.

pressure on the piston, when steam is cut off at three-quarters of the stroke, at 90, and indicator diagrams also show that at slow speeds as much as 90 per cent. of the boiler pressure is exerted on the pistons. For the purpose of illustration, we will take the indicator diagram shown in fig. 1, which was taken with a boiler pressure of 135 lbs. and gave an average pressure of 121.5. With 17 × 24 in. cylinders and 5½ ft. wheels, the tractive power from this diagram would be 12,800 lbs. if calculated in the usual way. The rule which is ordinarily used gives the *average* tractive force exerted. But the pressure on the crank pins at right angles to the crank, or the "rotative effect," as it is called, varies very considerably during each revolution of the wheel. In fig. 2 this is shown. The horizontal line *A E* is supposed to represent the circumference of the driving-wheel, stretched out into a straight line. One of the cranks is supposed to be at its dead points at *A C*, and *F*, and the other at *F* and *C*.

The rotative effect produced at the circumference of the wheel by the right-hand cylinder is represented by the vertical lines 1 *b*, 2 *c*, 3 *d*, 4 *e*, etc., through the lower extremities of which the curve *A F C G E* is drawn, so that the distance of this curve from the line *A B C D E* represents the tractive force exerted by one cylinder at the rail.* The

* The method of drawing a diagram of this kind will not be described here, but those interested in the method of doing it will find it explained in a treatise on the Steam Engine by Arthur Rigg, published by Spon, and in another excellent and more recent book on the steam engine by George C. V. Holmes, published by Appletons

horizontal lines and the figures on the left show the amount of this force in pounds. It will be seen that at the dead point *A* this cylinder produces no rotative effect, but it increases up to about the middle of the stroke at *B* and ceases again at the end of the stroke at *C*. This is repeated again while the piston is making its return stroke from *C* to *E*. The curve *A F C G E* shows the effect of the right-hand cylinder only. The left-hand piston is in the middle of the cylinder when the right-hand one begins its stroke at *A*. To show the effect of the pistons that of the left-hand one is laid off from the curve *A F C G E* on the vertical lines *A a'*, *b b'*, etc. A second curve *a' b' c' d' e'* is then drawn through the lower extremities of these lines. This curve will represent the tractive force or rotative effect, exerted at the circumference of the wheels *by the two cylinders*, because, as will be seen, the effect of the one cylinder is added to that of the other. At *F*, when the left-hand crank is at its dead point, the curves coincide, and so again at *G*, as at these points the left-hand piston produces no effect. It will be seen, though, that at *e' f' g'* and *h'*, when the cranks stand at an angle of 45°, the rotative effect is considerably greater than at the intermediate points. What is also notable is that the

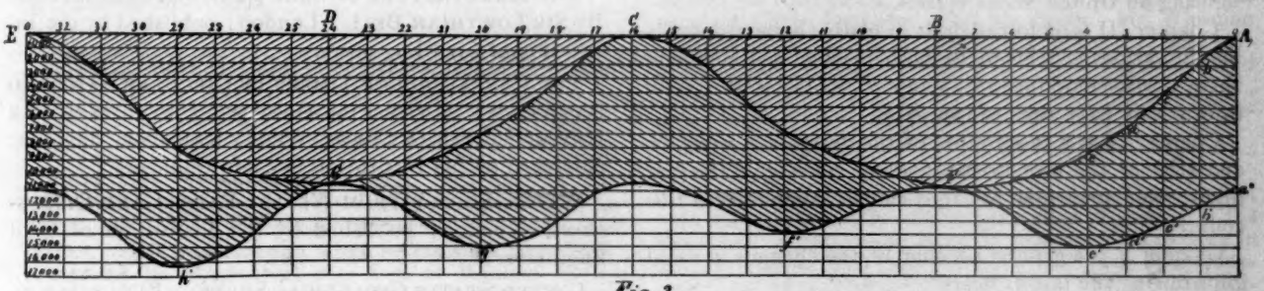


Fig. 2.

effect at *h'* is considerably greater than at any of the other points. The fact that a locomotive will start a greater load at one point in a revolution, has been noticed by locomotive runners and has often been denied by theorists. The practical men in this case were right.

The special point to which attention is directed is the great inequality of the rotative effect, or the tractive force, which is exerted by the pistons at the circumference of the driving-wheels. The calculation by the usual rule gives the *mean* tractive force, which is 12,800 lbs.; whereas, in the case illustrated, it varies from about 10,500 up to 16,500 lbs. during each revolution. If we assume the weight on the driving-wheels to be 50,000 lbs., and their adhesion equal to one-third the weight they bear, then the maximum tractive force would be just about equal to the adhesion, which would be 16,666 lbs. Of course, the tractive force should never exceed the adhesion, or the wheels will slip; nevertheless, it is important that we should always be able to turn the wheels under conditions which give the maximum adhesion. The fact, though, that the tractive power varies so materially during each revolution has not, thus far, been taken into account in calculating cylinder capacity. It would seem as though a proper basis for calculating cylinder capacity would be to take the adhesion at one-third the weight on the driving-wheels, and the average cylinder pressure at 85 or 90 per cent. of the boiler pressure, and then make the mean tractive capacity of the cylinders equal to three-quarters the adhesion of the wheels. As ¾ of ⅓ is ¼ these considerations lead to the same result as that reached by the Committee, although by a somewhat different method. There does not seem to be any very good reason, though, for adopting different co-efficients for adhesion for different classes of engines, because they all have occasion at times to use their maximum adhesion on dry, sanded rails, and if there is then not sufficient cylinder capacity the maximum load which the engine can draw will be diminished. It, therefore, would seem as though it would be best to assume one-quarter the weight on the driving-wheels as the adhesion of all classes of engines.

The problem which usually presents itself is to get the area of piston for a given stroke, diameter of cylinder and weight on driving-wheels. The formula of the Committee is not given in a convenient form for this calculation. If we take the formula for calculating the tractive power of locomotives:

$$\frac{A \times p \times 4\,S}{C} = \text{Tractive Power} = \frac{W}{4} \text{ in which}$$

A = Area of the piston in square inches.
p = Mean pressure in cylinders.
S = Stroke of piston.
C = Circumference of driving-wheels.
W = Weight on driving-wheels—the stroke and circumference being both expressed in feet or inches.

Then, as the tractive power should be equal to one-fourth the weight on driving-wheels, and the pressure in the cylinder 85 per cent. of the boiler pressure, which will be represented by P, then

$$\frac{A \times .85\,P \times 4\,S}{C} = \tfrac{1}{4}\,W$$

from which we have:

$$A = \frac{\tfrac{1}{4}\,W \times C}{.85\,P \times 4\,S}$$

Or expressed arithmetically to get the area of the pistons for a locomotive:

Multiply one-fourth the whole weight (in pounds) on the driving-wheels by the circumference of these wheels, when the tires are half worn out. Then multiply 85 per cent. of the boiler pressure (in lbs. per square inch) by four times the stroke of the piston, and divide the first product by the second. The quotient will be the area of each piston in square inches.

The circumference of the wheels must be expressed in the same units as the stroke of the pistons. That is, they must both be in feet or both in inches.

NEW PUBLICATIONS.

RECENT NAVAL PROGRESS: June, 1887. Navy Department, Bureau of Navigation; issued by the Office of Naval Intelligence.

As all naval matters have been for several years in a transition state, and as our own Navy in particular has just begun to assume an entirely new form, information on naval matters is now of special interest and importance. Such information, however, is not always easy to get at, much of it being hidden away in the proceedings of societies and in technical journals, where it is difficult to find it when wanted. The Navy Department has realized this fact and has made an excellent attempt at supplying the need in its "General Information Series," of which No. VI has just been issued.

While this volume is, of course, designed mainly for the use of naval officers, it has in it much that is of value to engineers, and indeed to all who take an intelligent interest in naval progress, as will be seen from the brief list of the contents given below.

Chapter I is a sketch of the development of the torpedo, with descriptions of the latest forms of these weapons.

Chapter II is an account of the development of electric lighting on United States vessels.

Chapter III is on forced draft in marine boilers, describing the various systems in use both on naval and merchant vessels. In compiling this chapter the latest sources of information have been drawn upon.

Chapter IV is a description of the design, construction and trial of the 8-in. breech-loading rifled gun, the first high-power steel gun of large caliber completed in this country.

Chapter V is a general account of the changes in naval guns during the last 25 years.

Chapter VI is an account of recent progress in small arms, with a description of the leading forms of magazine rifles now in use.

Chapter VII contains a synopsis of the musketry instructions in the United States and foreign forces.

Chapter VIII is a reproduction of a paper on the much discussed question of belted and internal armor for warships.

Chapter IX is an analytical description of the French and English naval manœuvres of last year.

Chapter X gives the results of the great competitive trials of anchors at Portsmouth, England.

The volume concludes with a number of short notes on progress made during the year in design and construction of vessels and their equipment, armament and machinery; and on many other points in connection with naval management and similar matters.

The contents of the present volume have been well selected and carefully edited. The Navy Department has made an addition to naval literature, whose value is quite sufficient excuse for its existence.

BOOKS RECEIVED.

REVISTA MENSAL DE ENGENHARIA E INDUSTRIA: ABRIL, MAIO E JUNHO. Rio de Janeiro, Brazil; published by the Club de Engenharia.

PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE: VOLUME XIII, NUMBER 3. Annapolis, Md.; published by the Institute. The present number contains papers on the Naval Brigade (prize essay for 1887); Training of Enlisted Men of the Engineers' Force; Iron and Steel and the Mitis Process; New Method of Carrying and Lowering and Detaching Boats, with a Suggestion for Defending Ships against Auto-mobile Torpedoes; Notes on the Literature of Explosives and on Electric Motors. The authors are Lieutenant C. T. Hutchins, U. S. N.; Passed Assistant Engineer W. M. Parks, U. S. N.; W. E. Durfee; Lieutenant D. H. Mahan, U. S. N.; Professor Charles E. Munroe and F. J. Sprague.

WATER SUPPLY IN THE CAPE COLONY: BY JOHN GEORGE GAMBLE. London, England; published by the Institution of Civil Engineers.

THE INTERSTATE COMMERCE ACT: A DISCUSSION OF THE PROVISIONS OF THE SECOND AND FOURTH SECTIONS. BY JOSEPH NIMMO, JR. Reprinted from *Frank Leslie's Illustrated Newspaper*.

THE IDEAL MODERN SCHOLARSHIP: BY HENRY SHALER WILLIAMS, PROFESSOR OF GEOLOGY, CORNELL UNIVERSITY, Ithaca, N. Y. This is a presidential address delivered by Professor Williams at the inauguration of the Alpha Chapter of the Sigma Xi Society at Cornell University.

THE MANUFACTURE OF SALT NEAR MIDDLESBROUGH: BY SIR LOWTHIAN BELL. London; published by the Institution of Civil Engineers.

THE CONVERSION OF TIMBER BY CIRCULAR SAWS AND BAND SAWS IN THE PINE-GROWING DISTRICTS OF THE UNITED STATES: BY LEWIS HENRY RANSOME. London; published by the Institution of Civil Engineers.

WATER SUPPLY FROM WELLS: PAPERS AND DISCUSSIONS. London; published by the Institution of Civil Engineers.

UNITED STATES GEOLOGICAL SURVEY: BULLETINS 34, 35, 36, 37, 38 AND 39. Washington; Government Printing Office.

SIXTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY: J. W. POWELL, DIRECTOR Washington; Government Printing Office.

ENGLISH AND AMERICAN RAILROADS COMPARED: BY EDWARD BATES DORSEY, C. E. New York; John Wiley & Sons. This is a reprint of Mr. Dorsey's paper read before the American Society of Civil Engineers; the book also contains the discussion on the paper by Messrs. W. W. Evans, Thomas C. Clarke and Edward P. North.

A TREATISE ON CABLE OR ROPE TRACTION AS APPLIED TO THE WORKING OF STREET AND OTHER RAILWAYS: BY J. BUCKNALL SMITH. C. E. London; *Engineering*, and New York; John Wiley & Sons.

THE NATIONAL CAR & LOCOMOTIVE BUILDER SUPPLEMENT: JUNE, 1887. New York.

OBITUARY.

J. B. CLOUGH, Assistant Chief Engineer of the Northern Pacific Railroad, died in Helena, Montana, August 22. He had been for some time in the service of the road.

MR. R. O. CARSCADIN died at his home in Trenton, Mo., July 25. He had been connected with the Chicago, Rock Island & Pacific road for many years, and Master Mechanic of the Southwestern Division of that road for 15 years past. He had been an active member of the Master Mechanics' Association for over 10 years.

DR. E. D. STANDIFORD died in Louisville, Ky., July 26, aged 56 years. He was a man of large wealth and had been connected with many railroad and other enterprises. He was President of the Louisville & Jeffersonville Bridge Company and was at one time for several years President of the Louisville & Nashville Railroad Company. He was a very active and energetic man and was better known as a financier than as a railroad manager.

WILLIAM C. MORRILL, of Atlanta, Ga., died in Boston, August 23, while on a visit to that city on business. Mr. Morrill had been for a number of years connected with the Western & Atlantic road, and for some years past Vice-President of that company. He also owned and controlled some large tracts of coal and iron lands in Georgia and Alabama, and was actively engaged in developing them.

ARCHIBALD CAMPBELL, who died in Washington, July 27, age 76 years, was a graduate of West Point and served in the Army till 1840. He was then engaged in surveys of western rivers for several years. He was afterwards, for four years, Chief Clerk of the War Department. In 1856, he represented the United States in the commission which laid out the northern boundary line from the summit of the Rocky Mountains to the Pacific Ocean, and in 1875 he served on the commission which completed the line from the Rocky Mountains to the Lake-of-the-Woods.

WILLIAM BAILEY LANG, one of the oldest of New York iron merchants, died at his home in Scarsdale, N. Y., August 5. He was 87 years old and was well known in the iron trade, having been virtually the life-long agent of the Lowmoor Iron Company, and for Charles Cammell & Co., Limited, of Sheffield, England. His office was at No. 50 Beekman Street. He retired from business in April, 1886. Mr. Lang was a prominent iron merchant in Boston nearly 50 years ago, when he came to New York. Afterward he established the firm of William Bailey Lang & Co., his partners being his sons-in-law, George M. Wheeler and Adams Bailey. The firm did a successful business as agents and importers. In 1877, misfortune overtook Mr. Lang and he made an assignment, but subsequently recovered much of his business prosperity.

WILLIAM BARBER BUDDICOME, who died at his residence in Flintshire, Wales, early in August, was born in Liverpool, England, in 1816. He served an apprenticeship in his native town, and when 20 years old, secured a position as Resident Engineer on the Manchester & Liverpool Railway. Subsequently he was Engineer on the old Glasgow, Greenock & Paisley line, and then Locomotive Superintendent of the Grand Junction Railroad. In 1841, he went to France to take charge of the rolling stock of the railroad then under construction from Paris to Rouen, and remained in that position until 1860. He was then, for a few years, engaged in some important contracts in France and Italy, including the Bellegarde Tunnel and a part of the Mt. Cenis road. About 1865, he retired from business and settled down in his native country. His services in France procured him the decoration of a Chevalier of the Legion d'Honneur. He was a member or the British Institution of Mechanical Engineers and the Institution of Civil Engineers, and also of the French Société des Ingénieurs Civils.

JOHN N. RISDON, for many years principal proprietor of the great iron works in San Francisco which still bear his name, died at Oakland, Cal., July 31, of paralysis, aged 69 years. He left the East in time to arrive in California in 1848 or 1849, but, crossing the Isthmus of Panama, he thought he saw an unusual opportunity for a mercantile venture, and opened a store at Panama. He remained on the Isthmus for nearly two years, then went to San Francisco. He was more attracted by business in San Francisco than by the mines, whither nearly all emigrants were flocking, and joined with John Snow in conducting small iron works. Later, he organized a corporation to construct and operate a foundry. He was the principal owner of the stock and President of the company, which was called the Risdon Iron Works Company. The enterprise was successful, and Mr. Risdon became a man of great wealth. In 1856, he was a member of the Vigilance Committee. Several years ago he sustained heavy losses, withdrew from the foundry, and since then has lived in retirement.

THOMAS T. WIERMAN, SR., died at his residence in Harrisburg, Pa., August 3, aged 74 years. He was born in Adams County, Pa., and learned surveying when still a boy. His first service as civil engineer was on the original construction of the Pennsylvania Railroad, and subsequently on the construction of the North Branch Canal, from Pittston to the State line of New York. He afterward constructed, as Chief Engineer, the Chemung Canal, which connected the water improvements of Pennsylvania with the New York State canals. After that he had charge of the building of the Barclay Railroad, running from Towanda, Bradford County, Pa., to the bituminous coal fields in that county. He also made the original surveys for the Brooklyn Water Works. Mr. Wierman took charge of the Pennsylvania Canal about the year 1857, being stationed at Huntingdon. In 1859, he removed to Harrisburg and continued in charge of that canal as Chief Engineer until his death. Mr. Wierman married Miss Piolett, of Bradford County, Pa., who survives him. He leaves two sons, both engineers, and three daughters, Mrs. S. S. Mitchell, of Buffalo, N. Y., Mrs. T. M. Ely, of Altoona, Pa., and Miss Sallie Wierman.

HORACE ABBOTT, one of the oldest and best-known iron manufacturers in the country, died August 8, at his residence in Baltimore, aged 81 years. He was born in Sudbury, Mass., and learned there the trade of a blacksmith, but soon extended his operations. He went to Baltimore in 1836 and soon afterward bought the Canton Iron Works from the late Peter Cooper. These works were gradually extended until they ranked among the largest in the country, and were known as the Abbott Iron Works. In these works were made the first large steamship shaft of wrought-iron in this country. It was for the Russian frigate *General Admiral* built for Nicholas I., in New York. It weighed 26,000 lbs. and aroused great interest when placed on public exhibition in New York. A great achievement of the Abbott Works during the war was in supplying the Government with 250,000 lbs. of rolled iron in 48 hours after receiving the order. They supplied Mr. Ericsson with the plates for armor of the *Monitor* and also supplied the plates for nearly all the vessels of that class built on the Atlantic Coast. Mr. Abbott retired from active conduct of business some years ago, and the works were operated by the Abbott Iron Company. They have been closed for some time, owing to the advantages which position and cheaper fuel have given to the iron makers in Pennsylvania and elsewhere in the close competition of later days.

Mr. Abbott was highly esteemed by his friends and business associates, and was a man of standing and influence in Baltimore.

PROFESSOR SPENCER F. BAIRD, Head of the Smithsonian Institution and of the United States Fish Commission, died August 19, at Wood's Holl, Mass., where he had been sick for some time.

Spencer Fullerton Baird was of mixed Scotch, English and German descent. His ancestors were preachers, surveyors, bankers and lawyers of New Jersey and Pennsylvania. His father was a lawyer of Reading, Pa. He is described as a man of high culture and close observation and an ardent lover of outdoor pursuits. His sons inherited his tastes.

At the age of 14, Spencer Baird, with his elder brother William, commenced a collection of game birds found in Cumberland County, Pa., which afterward was made the nucleus of the present magnificent Smithsonian Museum. The brothers contributed papers to the Philadelphia Academy of Sciences, which received marked attention, and soon afterward the great ornithologist, Audubon, became interested in Spencer Baird, and established a friendship with him which continued until Audubon's death and did much to shape the future career of his gifted protégé. Audubon presented him with a large part of his collection of birds, and young Baird in return contributed many facts and specimens to aid in the production of Audubon's works.

Professor Baird graduated from Dickinson College, at Carlisle, Pa., at the age of 17, and subsequently studied medicine in New York, although he never followed that profession. In 1845, when he was 22 years old, he was elected Professor of Natural History of the college at which he had graduated. Two years later he became associated with the distinguished Agassiz, and projected with him a work on the fresh-water fishes of the United States, which was never completed. During all this period it was his habit to make extended pedestrian tours for the purpose of extending his knowledge and enlarging his natural history collections. So great were his powers of physical endurance, that he had been known to cover nearly 60 miles on foot in one day between sunrise and rest.

In 1850, Professor Baird was elected Assistant Secretary of the Smithsonian Institution, with which his name and fame have since been indissolubly connected. On the death of Professor Henry he became the head of the Institution. In 1871, he was appointed, by President Grant, United States Commissioner of Fisheries, an office which added largely to his responsibilities and nothing to his compensation. The services he rendered in this capacity in increasing the food supply of the world would alone justify a national monument to his memory.

But Professor Baird's history is the history of the sysmatic zoology of the United States. A chronological catalogue of his works, prepared by order of the Smithsonian Institution and only carried down to 1882, includes over 1,000 titles. His services to science and natural history were rewarded by medals from the Acclimatization Societies of Australia, France and Germany. He was a member of the leading scientific associations of England, Austria, France, Germany, Holland, Portugal and New Zealand. Over 33 distinct genera and species in North, South and Central America and the West Indies have been named in his honor.

The extent of Professor Baird's labors and the practical service he has rendered as head of the Smithsonian Institution cannot be overstated. It is a melancholy fact that his last hours were embittered, and, according to the testimony of Professor Goode, his assistant, and other associates, his life was perceptibly shortened by causeless imputation cast upon his administration of the large fund placed at his disposal as head of the Fishery Commission. There never was the slightest foundation for those charges. They were investigated by the Appropriation Committee and found to be absolutely baseless, and the appropriation was continued without change. But the unjust suspicion struck home to Professor Baird's sensitive mind, and, with a brain and constitution enfeebled by incessant and long-continued overwork, hastened his death.

ALVAN CLARK, the founder of the great telescope works at Cambridge, Mass., died at his home in that city August 19.

Born in Ashfield, Mass., March 8, 1804, of parents who came from the Cape, and who traced their pedigree back to the early voyagers in the *Mayflower*, Mr. Clark was essentially a New England man. All the technical education he ever got he received in the public schools. At an early age, however, he showed a taste both for engraving and painting, and in his early manhood earned his living as a calico engraver at the Merrimac Works at Lowell, and elsewhere.

When he was 22 years of age Mr. Clark married. He still kept up his painting, and in 1835 gave up engraving entirely, and, removing to Boston, opened a studio on Tremont Street, making his home on Prospect Street in Cambridge. Here for 20 years he worked successfully as a portrait painter.

Mr. Clark was over 40 years of age when he became interested in telescope making. He had delighted in studying that scientific instrument during his leisure hours, and although he possessed no mathematical education, yet he was thoroughly conversant with optical principles. It is said that one day while he was watching his son make a metal reflector it occurred to him that he might be successful in the grinding of lenses, and, acting upon that idea, he soon produced object glasses equal in quality to any made. That determined his after life, for, giving up everything else, he, with his sons, began in 1846 the mauufacture of telescopes. Since then he had been unrivaled in his specialty of figuring object glasses.

Just before the war, Mr. Clark undertook the preparation of a glass 18 in. in diameter, 3 in. larger than any ever before made. That glass, which went to Chicago, revealed 20 stars in the nebula of Orion which had never before reached telescopic vision. It was with this instrument that Mr. Alvan G. Clark, Mr. Clark's son, in 1862, discovered the companion of Sirius, receiving the award of the Lalande medal from the French Academy of Science.

The present works of the firm were built in 1860. The Rev. W. R. Dawes, one of the leading amateur astronomers of England, has the credit of first bringing Mr. Clark's work into notice abroad. The number of instruments he made is very large. His cheapest one cost $300, while the national telescope he sold for $46,000, and the cost of the Lick glass was set at $50,000, without the mounting. A telescope of similar caliber to the national one was constructed for L. J. McCormick, of Chicago. The objectives alone to these instruments were worth $25,000 each, and were capable of a magnifying power of 2,000 diameters, and of increasing the surface of the object viewed to 2,500,000 times its natural size. This was the work of a man who had never seen a lens in process of construction in the hands of any one out of his own shop. The work necessary for the construction of such glasses may be conceived when it is understood that to make a good 4-in. objective a month's constant labor is required, while for an 8 or 10-in. objective a year is necessary.

But the triumph over these glasses was eclipsed by the subsequent work of the same firm on the telescope made for the Russian Government, and that which has been designed for the Lick Observatory in California. In 1870, the Russian Government contracted for an enormous telescope for the observatory at Pulkowa, and in 1883 the instrument was completed. The telescope was then the largest in existence, costing $33,000, having a clear aperture of 30 in., a 45-ft. focus, and weighing in the iron cell 418 lbs. It possessed a magnifying power of 2,000 diameters and was 7 in. longer in diameter than the instrument at Princeton Observatory, a few inches larger than the Washington telescope, both made by Alvan Clark & Sons. From the Imperial Academy of Science came a vote of thanks, and from the Emperor of Russia a gold medal.

The largest telescope in the world was to be eclipsed by a larger still, and to this end the firm undertook, a few years ago, the construction of a 36-in. object glass for the Lick Observatory. But an accident during an experiment about a year ago destroyed the photographic lens for this glass, and at the present time Mr. Alvan G. Clark is in Paris negotiating for another lens to take its place.

Mr. Clark was married on March 26, 1826, to Miss Maria Pease, of Conway, and they celebrated the sixtieth anniversary of the wedding last year. Mr. Clark's extraordinary power seemed to be acuteness of the eye, of the touch, and, finally, of the understanding, combined with unlimited patience. His manners were free and open, and his speech dignified. He had received honors from three colleges—Amherst in 1854, Princeton in 1865, Harvard in 1874. Mr. Clark leaves a widow and two sons—Alvan G. and George B. Clark.

Contributions.

Old Valve Motions.

To the Editor of the Railroad and Engineering Journal:

I HAVE read with pleasure several articles in your JOURNAL, and among them in particular that number of "The Rogers Locomotive Works" which treats of the valve motions used in former times. Mr. William Swinburne was the father of them, and the writer well remembers the different devices for locomotives and the trials to compete with the Bush Hill Works and the Baldwin Works of Philadelphia. If George Hollingsworth is alive in Paterson he could unfold a history of the Rogers trials on different roads in the years I speak of.

I see you speak of the Allen valve and link as constructed in 1873. I would like to know how it was given the name of "Allen." I saw the link, but not perfected as of late years, on the engines *Erin* and *Scotia*, built by Mr. Richard Eaton at Hamilton, Canada, in 1860. Also, I had charge of shops in Columbus, Ohio, and built several there in 1863, followed by Mr. Robert Curtis, the present Master Mechanic, who constructed No. 25 for that road in 1865. Since those dates I have used the same link and have with me the identical diary of 1864 with a full account of it, and also of Mr. William Romon's adopting it and applying it to the *Economy*, a locomotive placed in one end of a passenger coach. Again, I have with me the identical model I used in Columbus, O., in the winter of 1863-64 in constructing the straight-link motion, and I have built here on this island a locomotive from the same model of valve motion I used at Columbus in 1863-64. I have also a Mogul engine and do not bend or crook anything to get the link or radius-rod in, as I use a U rocker-shaft, both arms being elevated or turned upward, one connecting with the valve-rod; the valves are piston valves. The other arm connects with the link, and the rods run direct to the eccentrics on an angle above the line of the cylinders to clear the forward axle. The rocker-box is placed on the lower cylinder brace and in front of the forward drivers. The valve-rod slides in a box above the flat guides, secured to the guide-yoke, with valve connection extending back toward the cab, and couples to a pin attached to the rod. The valve-rod is ⅞ in. and the piston valve is 5 in. diameter; the steam-chest is around the cylinder, instead of on top. The valve can be opened at either end of the cylinder, and is my patent, with an improvement whereby I get rid of compression and vacuum and thus obtain the best results.

A flat valve when traveling or in motion lifts from the seat, if steam is not used, at each end of the stroke of the piston; this is caused by compression in the cylinder and vacuum in the steam-delivery pipe. This I do away with, as I have proved upon the locomotive just built for this company.

I worked for the Rogers Locomotive Works in 1844, 1845 and 1846, and I well remember the length of time consumed in constructing a locomotive; also nearly every man who was then employed there—many being scattered in after years. I was in the employ of the Schenectady Locomotive Works in Norris' time, before Walter McQueen was there and also after he came. I took from those works the first locomotive that ever went west of Lake Michigan; at the same time Peter and Jack Ebberts, of the Galena & Chicago Union, took up an old engine called the *Whittlesey*. I also worked for David H. Biggs on the old Syracuse & Utica Railroad (now part of the New York Central), while David Matthews had charge at Schenectady before J. Blackburn took charge there—and I well remember his "hump-back" smoke-stacks. Those were the days of railroad infancy. I also took from Schenectady the first engines for the Great Western Railway of Canada—called No. 1 *Hercules* and No. 2 *Sampson*—and many others, and through Mr. McQueen's advice I remained there many years as a locomotive engineer. On January 17, 1853, I ran the *Sampson* on the opening train, or excursion for the opening of the whole road; John T. Clark, Chief Engineer, and his associates—William Scott, Norman Booth, Charles Henson and William Bowman—were on the engine with me from London to Windsor.

I could tell a great deal more, but cannot get it into this letter. WALTER S. PHELPS.

FERRO-CARRIL DE GUANTANAMO, CUBA.

[NOTE.—The Allen straight link, which is an entirely distinct thing from the Allen *valve*, the two having no connection, was, we believe, first used, or at least first described, in 1855 or 1856, several years before the time named by Mr. Phelps, in his interesting letter of historical reminiscences. The Allen valve was used at the Rogers Works at the time stated in the book.—EDITOR.]

THE MILLER PLATFORM AND COUPLER PATENTS.

(Continued from page 255.)

THE next matter to be considered is the 1863 patent of Miller, both in its relation to the state of the art and as it bears upon the Janney coupling. The only claim of this patent which was pressed was the fourth, which is as follows: "The double beveled hooks *C C'*, disconnected from any coupling or bumper box constructed, arranged, and operated in the manner described."

Fig. 1 is a copy of a drawing taken from the Miller patent. The view is an inverted plan of the bottom of the car.

In this cut, the two hooks are shown fastened to their respective car beds *A A'*, and the double bevel of each hook is marked respectively *a* and *a'*, the letter *a* designating the inner bevel and the letter *a'* the outer bevel.

To keep the hooks *C C'* in their locked position after coupling, spring gates were used, which are marked *F*, one form being shown upon car *A* and another form upon car *A'*. With these gates, however, we have nothing to do.

It will be observed that no buffers of any kind are shown, and that the cars are close together, the ends of the car-beds almost meeting. The hooks *C* and *C'* cannot act as buffers, and, were it not for the meeting of the ends of the cars, they could approach each other to any extent as far as the couplings were concerned, these not opposing any resistance to the movement toward each other of the cars themselves.

It is difficult to state briefly the exact view taken by the complainants of the claim in controversy.

They held that the hook was to be independent of a coupling or bumper-box, though means of receiving the

shock when the cars met were to be present or might be present. They admitted that the Janney hook had not the bevel marked at *a'* (the outer bevel), but appeared to think that the inner bevel *a* was present.

The functions of the bevels are to separate the hooks laterally when the cars *A* and *A'* are forced together, and

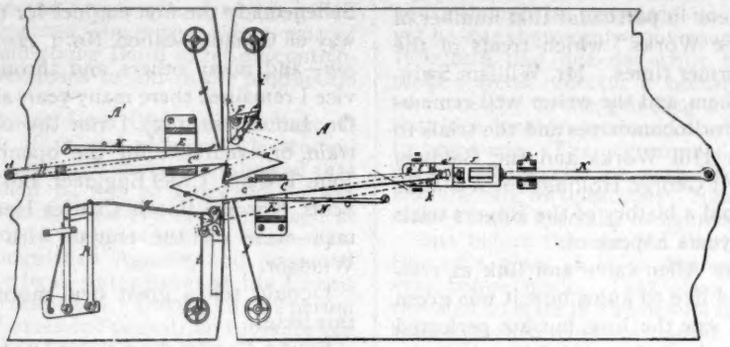


Fig. 1.

BOTTOM VIEW, MILLER'S PATENT, 1863.

the functions of the bevels *a'* are to open gradually the gates *F*. Now, according to the complainants, as the Janney hooks had no gates, they required no bevel *a'*, and therefore the claim might be read as requiring but a single bevel when such alleged equivalent devices were used. The view taken cannot be made clear here, for it was not clear at the time of the trial or since. On reading over the testimony, months afterward, the matter is not any clearer. However, without going into a careful review of the complainants' position in this matter, it will be best to refer at once to the state of the art and see just where Miller stood.

It is not deemed necessary to go into a detailed description of the Miller device as above shown, for, from the drawing, it will be evident to those readers who are mechanics precisely how the parts operated. The windlass for opening the hooks and the like mechanism for opening the gates is clearly shown and needs no explanation.

Among the earlier patents, the first which is worthy of notice is the patent of Joseph Miller, No. 11,940, dated Nov. 14, 1854.

This earlier Miller (who we believe was a cousin of Ezra Miller, the inventor we are speaking of) showed two hooks with a single bevel, but each pivoted in a bumper-box of old and well-known construction. The hooks were separated not by a sidewise motion as in the 1863 Miller patent, but by an up-and-down movement. Fig. 2 is taken from the 1854 patent of Miller, showing the parts partly in section.

This patent, the defendant contended, showed a single beveled hook and a bumper-box.

The next patent to be referred to is that of J. H. Jones, No. 12,680, dated April 10, 1855.

This patent showed two hooks held together by springs, and the specification indicates that these hooks can be used with or without bumper-boxes, though this is not exactly definite. Fig. 3 is a cut taken from the patent of Jones.

It will be seen that the hooks *C C* were provided with a bevel to separate them when the cars came together, and

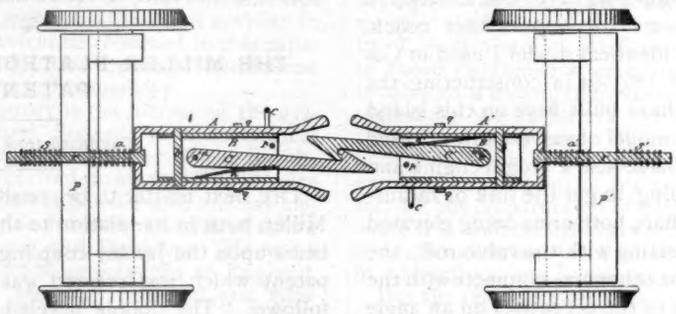


Fig. 2.

JOSEPH MILLER'S COUPLING, 1854.

that they were forced to couple and remain coupled by the springs *D D*. If no buffers or bumper-boxes were used, then the two ends of each hook would strike the

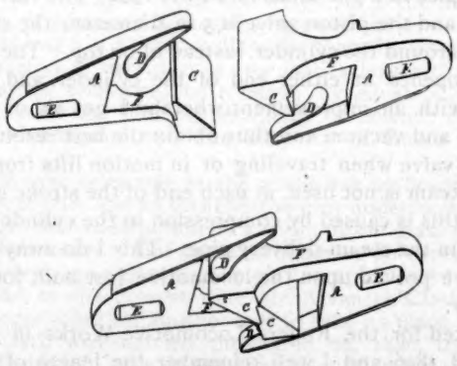


Fig. 3.

JONES' COUPLER, 1855.

cavity in the opposing hook, and a buffer would be thus formed.

The patent of E. L. Keeler, No. 24,938, dated Aug. 2, 1859, showed two hooks disconnected from any coupling or bumper-box. The hooks were separated by rotating

them. Fig. 4 is an engraving of the hooks taken from the patent.

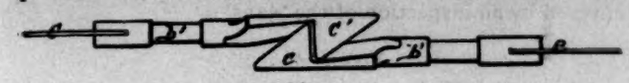


Fig. 4.

E. L. KEELER'S PATENT, 1859.

The patent of L. Adams, No. 26,403, dated Dec. 13, 1859, is illustrated in the accompanying cut, a bottom view being shown.

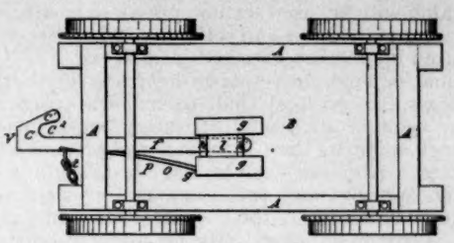


Fig. 5.

L. ADAMS' PATENT, 1859.

This patent, clearly and without doubt, shows a single beveled hook attached, as is Miller's, to a spring (as shown in the cut), and not connected with a coupler or buffer-box.

The drawing of the patent does not show the hook *C* as projecting quite far enough beyond the beam *A*, but this is probably a draftsman's error. Had this hook had another bevel it would in terms have met Miller's claim.

The patent of Birch & Noble showed two hooks connected with a coupling or buffer-box, the hooks working vertically; this patent was issued in 1862.

The hooks were double beveled, and one or the other might be uppermost in coupling. Each hook had two draw-faces.

The next patent of importance is that of M. Waterbury, No. 34,384, dated Feb. 11, 1862.

The accompanying cut (fig. 6) shows the mechanism.

In this structure a single beveled hook is shown, pivoted to a bumper-beam. The hooks are lettered *E E*, and the bumper is lettered *C*. The bumper-beam slides between the beams *B B*.

During the trial, it was suggested that Miller was the first to couple the cars closely together so that people would not fall between them, but this was shown not to be so by reference to the patent of C. Waterbury, No. 9,084, dated Jan. 29, 1852.

A view of the structure (fig. 7) is given, taken from the patent. The cut shows a top view in section of the ends of two cars.

In this device the blocks *B B* are elastic, and the platforms are enclosed, having doors leading to the steps. The coupling was of an old form having a buffing-box, but instead of a link, a coupling-bar was used having a hole at either end. The coupling or buffing-box itself was provided with springs. The patent recognized the advantages of close coupling and pointed out the safety to passengers which would follow from such a construction and arrangement of the parts.

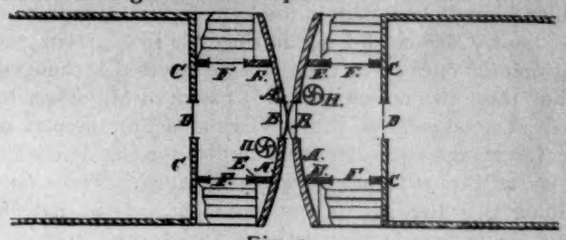


Fig. 7.

WATERBURY'S COUPLER, 1852.

The foregoing gives a clear idea of the state of the art at the time of Miller's 1863 patent.

It will be seen that, before Miller's 1863 patent, no one example existed of a hooked headed coupling, with the two bevels *a a'* and which was disconnected from a coupling or bumper-box. But, however, numerous examples existed of single beveled hooks connected with a coupling or bumper-box.

Now turn to the Janney coupler.

The hooks are formed by the pivoted tongues which,

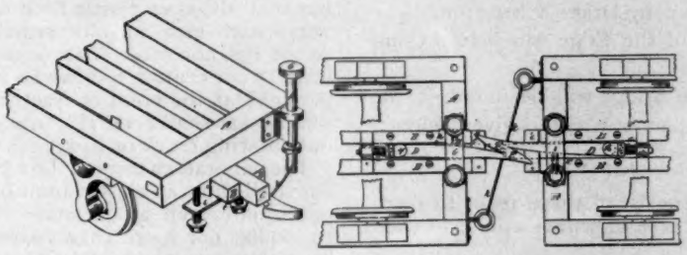


Fig. 6.

WATERBURY'S COUPLER, 1862.

when fastened in one position, constitute a hook, and which, when left free, open so that no hook is formed. There is no sidewise motion of the coupler-shank as a whole as in Miller's, but only of the tongue. When the couplers of two cars are locked together the couplers act as buffers, and in fact do more in this regard than do the two side buffers. Springs are specially arranged on the shanks of the Janney couplers to act as buffers, and this function they must effectually perform. Now, it follows from this that the Janney coupling is not a hooked-headed coupling disconnected from a coupling or bumper-box, but is in fact a hooked-head coupling connected with a buffing-box, and in this regard it differs from the terms of Miller's fourth claim and is like the earlier examples shown by the state of the art.

Next, Janney's coupling has no double bevel. It can scarcely be said to have a single bevel. It certainly has not got the bevels *a* and *a'* of the Miller patent, and neither has it the operation which requires the use of these bevels. This is the view that the Court took, saying as follows:

The construction asked for by the plaintiff would necessarily eliminate from the claim in question one of the bevels referred to As I have said, the Court has felt that it could not without doing violence to the law in that respect construe the claim as omitting one of the bevels when the patentee has included both.

It being conceded by the experts on both sides, as you will doubtless recollect, that there is no equivalent in the Janney hook or coupler for the outside bevel, there can be no pretense that the claim is infringed.

Thus the Court passed on the question of infringement of the claim under consideration. Another reason existed for the withdrawal by the Court of the fourth claim of this 1863 patent from the jury, and this reason was that Miller himself had said, in the letter before quoted, that the Janney device did not infringe his 1863 patent, and this opinion once given could not be reversed or changed.

For these two reasons the 1863 patent of Miller was by the Court taken from the jury, which act on the part of the Court was equivalent to a verdict for the defendant as far as the 1863 patent was concerned. The Court holding that the patent was not infringed and that the Miller heirs were by their father's act estopped from saying that the Janney devices came within the scope of the claim.

THE RULO BRIDGE.

THE accompanying illustrations show the three short shore spans and one river span of the new bridge over the Missouri at Rulo, Neb.; also the details of the long or river span.

This bridge, now nearly completed, has been built for the Chicago, Burlington & Quincy Railroad Company under the supervision of Mr. George S. Morison as Chief Engineer. The foundations were put in by the company, and the masonry was put up by Drake & Stratton. The superstructure is the work of the Edge Moor Iron Company, of Wilmington, Del.

A full description of the bridge will be found in the specifications, the material part of which is given below:

GENERAL DESCRIPTION.

The superstructure will consist of three main through spans and six deck spans, three of which will be at each end of the structure.

Each through span will be 375 ft. long between centers of end pins, divided into 15 panels of 25 ft. each. The trusses will be 50 ft. deep and placed 22 ft. apart between centers. The top chord, end posts, bolsters, rollers, bearing plates, pins and all eye-bars, except counters and vertical suspenders, will be of steel; all other parts will be of wrought-iron, except the wall-plate pedestals and ornamental work which will be cast-iron. Each span will contain approximately 486,000 lbs. of steel, 484,000 lbs. of wrought-iron and 21,000 lbs. of cast-iron.

Each deck span will be 125 ft. long between centers of end pins, divided into 5 panels of 25 ft. each. The trusses will be 17 ft. 6 in. deep and placed 12 ft. apart between centers. The intermediate ends of each set of three spans will rest on iron towers measuring 25 ft. long in the direction of the bridge, making a total length of iron work in each group of three deck spans of 425 ft. The pins, rollers, bearing plates and eye-bars, excepting counters, will be of steel; all other parts will be of wrought-iron, except the wall-plate pedestals which will be of cast-iron. Each span will contain approximately 102,000 lbs. of wrought-iron and 31,000 lbs. of steel. Each group of three spans, including the towers, will contain approximately 93,000 lbs. of steel, 398,000 lbs. of wrought-iron and 16,000 lbs. of cast-iron.

The total estimated weight of the entire structure is approximately 4,000,000 lbs.

PLANS.

Full detail plans, showing all dimensions, will be furnished by the Engineer. The work shall be built in all respects according to these plans. The contractor, however, will be expected to verify the correctness of the plans, and will be required to make any changes in the work which are necessitated by errors in these plans, without extra charge, where such errors could be discovered by an inspection of the plans.

MATERIALS.

All materials shall be subject to inspection at all times during their manufacture, and the Engineer and his inspectors shall be allowed free access to any of the works in which any portion of the material is made. Timely notice shall be given the Engineer so that his inspectors may be on hand.

Steel.—The steel used will be of two classes, viz.: High Steel, which will be used in compression members, bolsters, bearing plates, pins and rollers; and Low Steel, which will be used for tension members and rivets.

Steel may be made by the open-hearth or by the Bessemer process, but no steel shall be made at works which have not been in successful operation for at least one year; steel made by the Clapp-Griffiths process will not be accepted. All melts shall be made from uniform stock, low in phosphorus, and the manufacturer shall furnish satisfactory evidence to the Engineer that this class of material is being employed, it being understood that the furnished product is to be one in which the phosphorus does not average more than 0.08 per cent. and never exceeds 0.10 per cent.

A sample bar ¾ in. in diameter shall be rolled from every melt; the method of obtaining the piece from which this sample bar is rolled shall be the same for all samples, and the amount of work on this sample bar shall be as nearly as practicable the same as on the finished product. The laboratory tests shall be made on this sample bar in its natural state without annealing.

The laboratory tests of High Steel made on the sample bar shall show an elastic limit of not less than 50,000 lbs. per square inch, an ultimate strength of not less than 80,000 lbs. nor more than 90,000 lbs., an elongation of at least 15 per cent. in 8 in. and a reduced area of at least 35 per cent. at the point of fracture. In a bending test, the sample bar shall bend 180° around its own diameter without showing crack or flaw.

The laboratory tests of Low Steel made on the sample bar shall show an elastic limit of not less than 40,000 lbs. per square inch, an ultimate strength of not less than 70,000 lbs. nor more than 80,000 lbs., an elongation of at least 18 per cent. in a length of 8 in., and a reduction of at least 42 per cent. at the point of fracture. In a bending test, the sample bar shall bend 180° and close back against itself without showing crack or flaw on the outside of the curve.

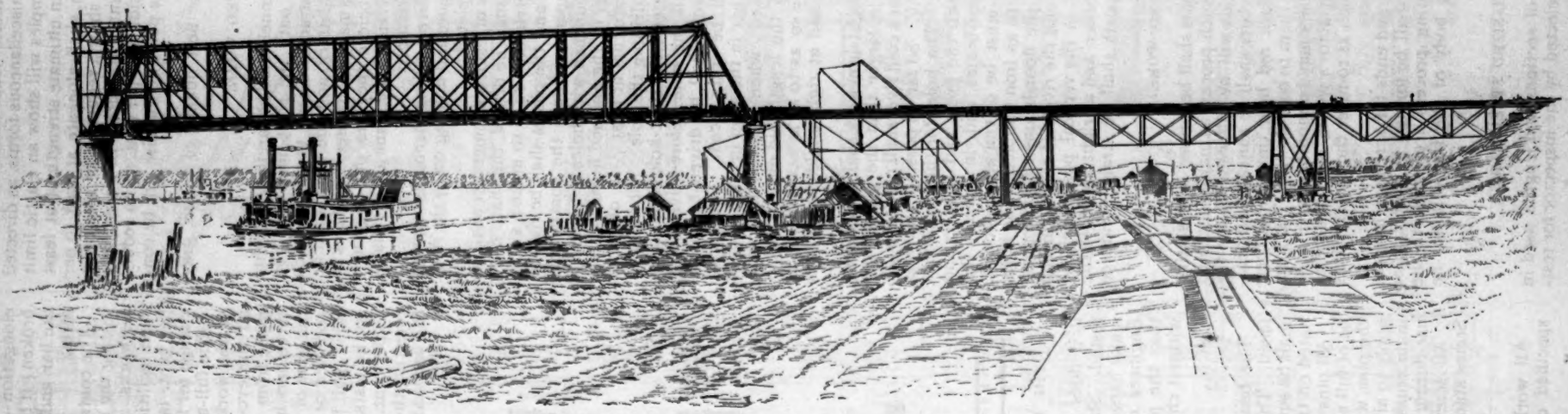
The softest melts shall be selected for rivets, and the only requirements as to elastic limit and ultimate strength will be that the ultimate strength shall be at least 60,000 lbs. per square inch.

Facilities for testing sample bars shall be furnished by the contractor at a point convenient to the steel works, and the tests shall be made at the expense of the contractor and under the direction of the Engineer. Tests may also be made from time to time on samples cut from finished plates, shapes and bars, which shall show results substantially conforming to those shown by the sample tests of the same melts.

All sheared edges or punched holes in steel work shall be subsequently planed or drilled out, so that none of the rough surface is ever left upon the work. Steel for pins shall be sound and entirely free from piping.

Wrought Iron.—The iron used in tension members shall be double-refined (high test) iron; muck bars may be used at the center of the pile, but shall not constitute more than one-third of the total pile. Small samples, having a minimum length of 8 in., shall be furnished by the contractor for testing, as directed by the Engineer; these samples shall show an elastic limit of at least 26,000 lbs. and an ultimate strength of at least 50,000 lbs. per square inch, shall elongate at least 15 per cent. and shall show a reduced area of at least 25 per cent. at the point of fracture. The fracture shall be of uniform fibrous character, free from crystalline appearances.

Small samples, having a minimum length of 8 in., shall



BRIDGE OVER THE MISSOURI RIVER AT RULO, NEBRASKA; CHICAGO, BURLINGTON & QUINCY RAILROAD.

GEORGE S. MORISON, CHIEF ENGINEER.

THE EDGE MOOR IRON COMPANY,
DRAKE & STRATTON,
} CONTRACTORS.

be furnished by the contractor from the iron used in shapes, plates and other miscellaneous forms, as directed by the Engineer; these samples will show an elastic limit of at least 24,000 lbs. and an ultimate strength of at least 47,000 lbs. per square inch, shall elongate at least 10 per cent. before breaking, and show a reduction of area of at least 15 per cent. at the point of fracture. In plates more than 30 in. wide an elongation of 8 per cent. and a reduction of 12 per cent. at the point of fracture will be considered satisfactory.

Cast-iron shall be of the best quality of tough, gray iron.

RIVETED WORK.

All plates, angles and channels shall be carefully straightened before they are laid out; the rivet-holes shall be carefully spaced in truly straight lines; the rivet-heads shall be of hemispherical pattern, and the work shall be finished in a neat and workmanlike manner. Surfaces in contact shall be painted before they are put together. The dimensions given for rivets on the plans are the diameters of the rivets before driving.

Power riveters shall be direct-acting machines, capable of exerting a yielding pressure and holding on to the rivet when the upsetting is completed.

Steel.—The several parts of each steel member shall be assembled, and the holes shall be drilled, the sharp edge of the drilled hole shall be trimmed so as to make a slight fillet under the rivet head, and the pieces shall be riveted together without taking apart. Should the contractors desire, the parts may be punched with holes not exceeding four-fifths the diameter of the finished hole, and this punching shall be so accurate that at least $\frac{1}{16}$ in. of metal is taken out all around in drilling the hole. All rivets in steel members shall be of steel; the rivet-holes shall be of such size that they will fill the hole before driving, and whenever possible the rivets shall be driven by power. All bearing surfaces shall be truly faced. The chord pieces shall be fitted together in the shop in lengths of at least five panels and marked; when so fitted there shall be no perceptible wind in the length laid out. The pin holes shall be bored truly so as to be at exact distance, parallel with one another, and at right angles to the axis of the member.

Wrought Iron.—All wrought-iron work shall be punched accurately with holes $\frac{1}{16}$ in. larger than the size of the rivet, and when put together a cold rivet shall pass through every hole without reaming. So far as possible all rivets shall be driven by power. The holes for the rivets connecting the floor-beams with the posts and bolsters and the stringers with the floor-beams, and, in general, the holes for all rivets which must be driven after erection, shall be accurately drilled to an iron templet. The holes for the rivets connecting the floor-beams with the posts shall be 1 in. in diameter, and the rivets of corresponding diameter. The pin-holes in the vertical posts shall be truly parallel with one another and at right angles to the axis of the posts. The posts shall be straight and free from wind.

FORGED WORK.

The heads of steel eye-bars shall be formed by upsetting and forging into shape by such process as may be accepted by the Engineer. No welds will be allowed. After the working is completed, the bars shall be annealed by heating them to a uniform dark red heat throughout their entire length and allowing them to cool slowly. The form of the heads of steel eye-bars may be modified to suit the process in use at the contractor's works, but the form of head adopted must be such as to meet the requirements of the tests of full-sized bars.

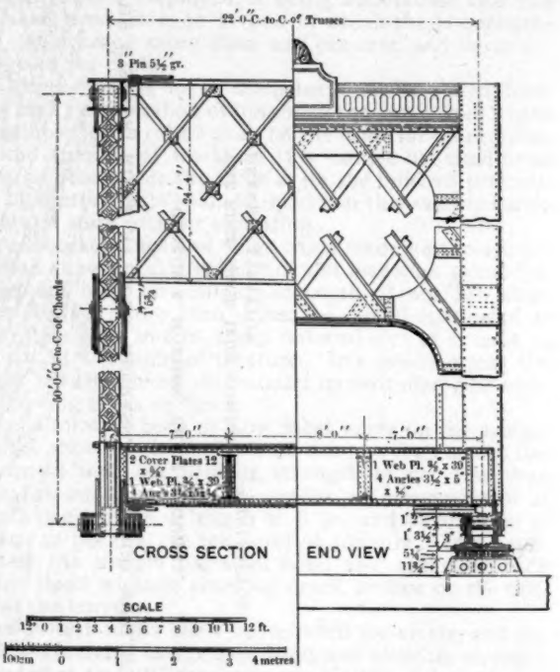
The heads and the enlarged ends for screws in laterals, suspenders and counters shall be formed by upsetting or by an upsetting and welding process acceptable to the Engineer. Welds in the body of the bar will not be allowed.

TESTS OF FULL-SIZED STEEL BARS.

Ten full-sized eye-bars of sections and lengths used in the actual work shall be selected by the inspector for testing; each of these full-sized bars shall be strained till an elongation of 10 per cent. is obtained, and, if possible, broken; if broken, the fracture shall occur in the body of the bar and shall show a uniform ductile quality of material.

The contractor will be required to furnish facilities for testing the full-sized bars within a reasonable distance of his works. Should the contractor be unable to furnish such facilities, he shall be required to furnish bars at 20 per cent. larger section than those called for, without change for the increased weight.

The full-sized bars shall be selected from time to time as the work proceeds, the last bar not to be selected till all the eye-bars are manufactured. The tests shall be made from time to time as the bars are selected. When three bars have been tested, the bars manufactured up to the time of the selection of these three test bars shall be accepted or rejected as the results of such tests, and the same shall be done again when three more bars are tested. In the tests, the failure of one bar to develop a stretch of 10 per cent. before breaking shall be sufficient reason for rejecting the whole lot; but a failure to break in the body of the bar shall not be a sufficient ground for condemnation


22'-0" C.-to-C. of Trusses
8 Pin 5½" gr.
90'-0" C.-to-C. of Chords
7'-0"
8'-0"
7'-0"
2 Cover Plates 12 x ⅝"
1 Web Pl. ⅝" x 30"
4 Angles 3½" x 5" x ½"
1 Web Pl. ⅝" x 30"
4 Angles 3½" x 5" x ½"
CROSS SECTION
END VIEW
SCALE
12' 0 1 2 3 4 5 6 7 8 9 10 11 12 ft.
10cm 0 1 2 3 4 metres

THE RULO BRIDGE, DETAILS OF 375 FT. SPAN.

if it does not occur in more than one-third of the bars tested. Should the contractor on the first attempt fail to make bars coming up to the required specifications, the Engineer may order bars of 20 per cent. larger section than the plans call for, to be furnished by the contractor without charge for the increased weight.

MACHINE WORK.

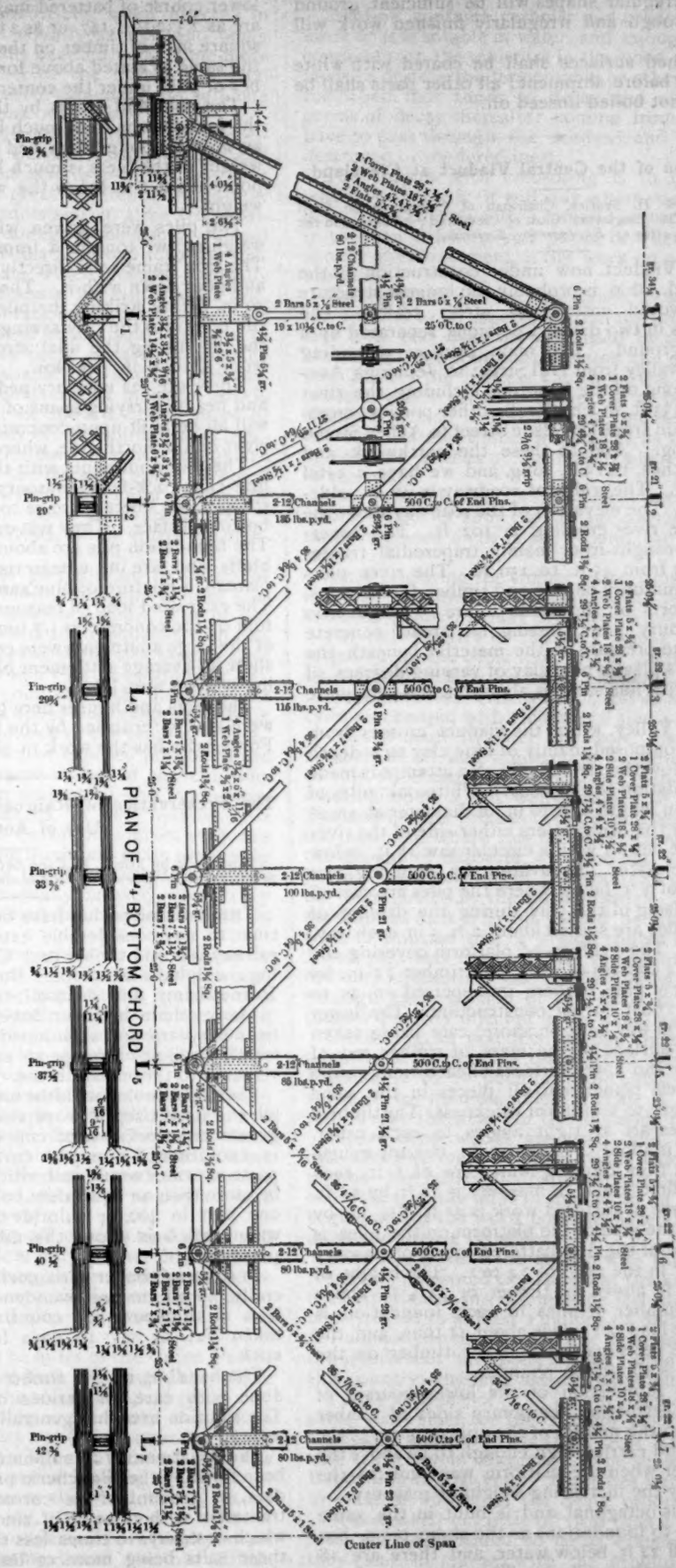
The bearing surfaces in the top chord shall be truly faced. The ends of the stringers and of the floor-beams shall be squared in a rotary facer. All surfaces so designated on the plans shall be planed.

All pins shall be accurately turned to a gauge, and shall be of full size throughout; pin-holes shall be bored to fit the pins, with a play not exceeding 0.02 in. These clauses apply to all lateral connections as well as to those of the main trusses. Pins shall be supplied with pilot nuts for use during erection, four for each size of pin.

All screws shall have a truncated V-thread, United States standard.

MISCELLANEOUS.

All workmanship and material, whether particularly specified or not, must be of the best kind now in use in



BRIDGE OVER THE MISSOURI RIVER AT RULO, NEBRASKA; CHICAGO, BURLINGTON & QUINCY RAILROAD

GEORGE S. MORISON, CHIEF ENGINEER.

THE EDGE MOOR IRON COMPANY, } CONTRACTORS.
DRAKE & STRATTON, }

first-class bridge-work. Flaws, ragged edges, surface imperfections or irregular shapes will be sufficient ground for rejection; rough and irregularly finished work will not be accepted.

Machine-finished surfaces shall be coated with white lead and tallow before shipment; all other parts shall be given a coat of hot boiled linseed oil.

The Foundation of the Central Viaduct at Cleveland.

[Report read by W. H. Searles, Chairman of Committee on Civil Engineering of the Civil Engineers' Club of Cleveland; published in the *Journal of the Association of Engineering Societies.*]

THE Central Viaduct now under construction in the city of Cleveland, Ohio, is probably the longest structure of the kind devoted entirely to street traffic. The superstructure is in two distinct portions, separated by a point of high ground. The main portion extending across the river valley from Hill Street to Jennings Avenue is 2,840 ft. long on the floor line, including the river bridge, a swing 233 ft. in length; the other portion, crossing Walworth Run from Davidson Street to Abbey Street, is 1,093 ft. long. Add to these the earthwork and masonry approaches, 1,415 ft. long, and we have a total length of 5,348 ft. The width of roadway is 40 ft.; sidewalks, 8 ft. each. The elevation of the roadway above the water level at the river crossing is 102 ft. The superstructure is of wrought-iron, mainly trapezodial trusses varying in length from 45 ft. to 150 ft. The river piers are of first-class masonry on pile and timber foundations. The other supports of the viaduct are wrought-iron trestles on masonry piers, resting on broad concrete foundations. The pressure on the material beneath the concrete, which is plastic blue clay of varying degrees of stiffness mixed with fine sand, is about one ton per square foot.

The Cuyahoga Valley, which the viaduct crosses from bluff to bluff, is composed mainly of blue clay to a depth of over 150 ft. below the river level. No attempt is made to carry the foundation to the rock. White-oak piles of from 50 to 60 ft. in length and 10 in. in diameter at small end are driven for the bridge piers either side of the river bed, and these are cut off with a circular saw 18 ft. below the surface of the water. Excavation by dredging was made to a depth of 3 ft. below where the piles are cut off to allow for the rising of the clay during the driving of the piles. The piles are spaced about 2 ft. 5 in. each way, center to center. The grillage or platform covering the piles consists of 14 courses of white-oak timber 12 in. by 12 in. having a few pine timbers interspersed so as to allow the mass to float during construction. The lower half of the platform was built on shore, care being taken to keep the lower surface of the mass of timber out of wind. The upper and lower surfaces of each timber were dressed in a Daniels planer, and all pieces in the same course were brought to a uniform thickness. The timbers in adjacent courses are at right angles to each other. The lower course is about 58 ft. by 22 ft., the top course about 50 by 24 ft., thus allowing four steps of 1 ft. each all around. The first course of masonry is 48 ft. by 21 ft. 8 in.; the first course of battered work is 41 ft. 8½ in. by 16 ft. 3 in. Thus the area of the platform on the piles is 1,856 square ft. and of the first battered course of masonry 777.6 square ft., or in the ratio of 2.4 to 1. The height of the masonry is 78 ft. above the timber, or 73½ ft. above the water. The number of piles in each foundation is 312. The average load per pile is about 11 tons, and the estimated pressure per square inch of the timber on the heads of the piles is about 200 pounds.

To prevent the submersion of the lower courses of masonry during construction, temporary sides of timber were drift-bolted to the margin of the upper course of the timber platform, and carried high enough to be above the surface of the water when the platform was sunk to the head of the piles by the increasing weight of masonry.

The center pier is octagonal, and is built in the same general manner as to foundations as the shore piers, but the piles are cut off 22 ft. below water, and there are 18 courses of timber in the grillage. The diameter of the platform between parallel sides is 53 ft., while that of the lower course of battered masonry is but 37 ft. The areas are as 2,332 to 1,147, or as 2 to 1, nearly. The pressure per square inch of timber on the heads of the piles is about the same as stated above for the shore piers. The number of piles under the center pier is 483.

The risks and delays by this method of constructing the foundations were much less, and the cost also, than if an ordinary coffer dam had been used. Also the total weight of the piers is much less, as that portion below a point about 2 ft. below the water adds nothing to their weight.

The piles were driven with a Cram steam hammer weighing two tons, in a frame weighing also two tons. The iron frame rests directly upon the head of the pile and goes down with it. The fall of the hammer is about 40 in. before striking the pile. The total penetration of the piles into the clay averaged 27 ft. The settlement of the pile during the final strokes of the hammer varied from ¼ to ¾ in. per blow.

There are 122 masonry pedestals, of which 8 are large and heavy, carrying spans of considerable length. They will all be built upon concrete beds except a few near the river on the north side, where piles are required.

The four abutments with their retaining walls are of first-class rock-faced masonry. The footing courses are stepped out liberally, so as to present an unusually large bottom surface. They rest on beds of concrete 4 ft. thick. The foundation pits are about 50 ft. below the top of the bluffs and are in a material common to the Cleveland plateau, a mixture of blue sand and clay with some water. The estimated load of masonry on the earth at the bottom of the concrete is 1.7 tons to the square foot. Two of the large abutments were completed last season. They show an average settlement of ⅜ in. since the lower footing courses were laid.

The facts and figures here given regarding the viaduct were kindly furnished by the City Civil Engineer, C. G. Force, who has the work in charge.

The Preservation of Railroad Ties and Timber by the Use of Antiseptics.

[Paper read by Joseph P. Card before the Western Society of Engineers; from the *Journal* of the Association of Engineering Societies.]

THE antiseptics that have been used up to the present time, to any considerable extent, in the preservation of railway ties and timber are: Corrosive sublimate, kyanizing; sulphate of copper, Boucherie; chloride of zinc, Burnettizing; and dead-oil, creosoting.

Many others, however, have been tried in the past 50 or more years, and abandoned for one cause and another, which I will not attempt to explain, but will confine my remarks to those now in use.

Corrosive sublimate is the most powerful poison of them all, and its antiseptic properties are some 50 or more times greater than sulphate of copper or chloride of zinc; that is, a solution of one part corrosive sublimate in 10,000 parts of water would, according to the best authorities, be more than an equivalent to sulphate of copper, diluted one part in 400, or chloride of zinc, one part in 200 of water, which is about the minimum at which they will preserve.

In treating timber with corrosive sublimate, it is generally placed in large wooden vats for one day for each inch in thickness, not counting the day it is put in or taken out, or say 10 days for an 8 in. × 8 in. square stick.

The handling of the timber after treatment has to be done with care, or serious consequences may follow. The solution used has generally been one part in 100 of water.

The treatment with sulphate of copper has generally been done by the Boucherie process, or in copper cylinders, on account of its corrosive properties, while the treatment with chloride of zinc is done in iron cylinders, which cost, say, 10 times less than copper. All three of these salts being more or less liable to be chemically changed or washed out of the wood, and as the chloride

of zinc has, under most conditions, when injected in proper quantities, answered equally as well, and being cheaper and more economically handled, it has come more generally into use than either of the others. In fact, comparatively speaking, corrosive sublimate and sulphate of copper have practically gone out of use.

Chloride of zinc has served a good purpose in the preservation of railroad ties in Germany, while in England the treatment has not been satisfactory—in fact, has been abandoned. Now, why this great difference in results? The road-beds are, as I understand it, alike (rock-ballasted); consequently, the drainage is the same. It must be on account of the impurities absorbed into the ties, from England's moist climate, which changes gradually the chloride into a non-antiseptic, for rainfall, as a rule, will not, so far as my observations go, wash it out. It takes more than rain; in fact, it means submerging it in water, and this would hardly occur on a rock-ballasted roadbed. If a tie were reasonably dry and in rock ballast, and it should rain, it would absorb moisture slowly as it rained; the flow would be inward, taking more or less of the salt with it, for any of the soluble salts mentioned will, to a certain extent, move around through the wood in whatever direction the moisture goes. When it rains, it goes inward or towards the center; when the moisture evaporates, to the point of evaporation. I have had this tested by analysis, to my entire satisfaction.

If ti s were submerged, or partially so, in water for any considerable time, the chloride being of greater specific gravity than water, its tendency would be to go out of the ties rather than inward, or to equalize with the water surrounding them. Again, if the ties were in sand (like the Rock Island ties, which I will mention later on), the result would be, when your sand was moist or wet they would absorb moisture where they came in contact with it, and as it gradually moved to the point of evaporation, which would be the top or exposed portion of the tie, it would carry with it more or less of the chloride. This constant or, at certain seasons of the year, long-continued, evaporation weakens, in my opinion, the strength of the chloride at point of contact with the ground or moisture below the minimum of its preserving properties, and in the case of the Rock Island ties, which were in clean sand, they gradually decayed where they came in contact with the ground, but remained sound on top, as a general thing.

Again, should there be impurities in the ground or water surrounding the ties, or in the rainfall, that would combine with the chloride or any salt and transform it into a non-antiseptic, as oxide of zinc, the change would be more or less rapid, and it is in this way that I account for the bad results with chloride of zinc in England; and from rainfall, if the ties are on rock ballast.

I know of Burnettized gumwood ties that were placed in cinder and slack-coal ballast in 1880 (the cinders and slack came from a coal-mine dump which had been burned over) which were worthless in 12 months after being placed in the track, while ties treated at the same time, that were placed in sand, are sound to-day, or were when I examined them last year.

I do not mean to say that all cinders and slack will produce this result, but these did; neither do I wish to convey the idea that the changes mentioned heretofore occur in a day. Some of them may in a month, or, as in the case of the Rock Island ties, their average life was over 15 years.

There is a section of some 20 miles of the Union Pacific Railroad where the ties have been preserved, ever since the road was first built, by the soil in which they lie.

With reference to creosoting or the use of dead-oil in wood-preserving, if you inject a sufficient quantity of oil (of proper quality, after steaming and vacuum) into ties or timber, they will remain sound so long as the oil remains undisturbed, if it enters the wood but ½ in., or even less, on the sides of, say, a 10 in. × 10 in. stick of timbe , notwithstanding the oil remains practically where it is placed at time of treatment, and does not diffuse through the wood, like chloride of zinc, and for the following reasons:

Dead-oil contains carbolic and other acids, which are more or less soluble in water, and enough of these acids combine with the moisture in the wood at time of treatment to destroy the fermentable or other matter then in the wood, that tends to decay, and any impurities or germs of decay thereafter coming from the outside will have to pass through the dead-oil, and in doing so are destroyed or rendered inert.

The trouble with creosoting is to get the dead-oil where you want it (it will stay where you put it) and the cost. The trouble with a mineral salt or chloride of zinc is to keep it where you put it, or where it places itself shortly after treatment, if the work on your part is properly done.

Having given you my experience, as well as ideas as to the benefits to be expected from the proper use of mineral salts and dead-oil when used by themselves, I will now submit for your consideration and discussion before this Society the process known as the "zinc-creosote" process, which consists in the use of both dead-oil and chloride of zinc in combination, for the preservation of railroad ties and timber from decay, as well as protection against the attacks of the teredo where timber is placed in the sea.

For railroad ties, bridge-timber and the like, or where timber is subjected to no considerable moisture, as when placed on or in the ground, the process is as follows:

After preparing the timber in the usual way, by steaming and vacuum, the dead-oil is run into the cylinder, and such quantity as may be desired is forced into the wood.

For railroad ties or timber, I would recommend, say, ½ gallon to the cubic foot, or 1½ gallons to the tie. A less amount may be found to answer. After the timber has been treated with oil, the oil is removed and the cylinder charged with chloride of zinc, when, by pressure, it can be made to enter the wood, pass through and beyond the oil, and impregnate by diffusion that portion of the wood that the oil will not penetrate, especially where timber is not well-seasoned or dense like oak. The aim of this process is to get the benefit of the dead-oil treatment where ties or timber come in contact with the ground or moisture, with one-half or less oil, besides having those portions of the wood not penetrated by the oil impregnated by the zinc chloride. The zinc chloride, surrounded as it is by oil, should be protected for a long time in railroad ties or bridge timber against moisture. I find that less than one-half the quantity of oil used in ordinary creosoting can be distributed by this process through every portion of the wood penetrated by the greater quantity injected in the usual way.

Creosoting, as practiced abroad, unless a much larger quantity of oil is used on railroad ties than is used in England (6 to 10 pounds to the cubic foot), is of little value, in my opinion, unless a chair is placed under the rail, to take the wear, for the following reasons:

Where dense woods are used—and, in fact, it is the case also with many of those woods which are considered porous—the heart-wood will take the oil but skin-deep; consequently, the oil is in time worn off by the rail, decay begins, and at the worst possible place, the spike becomes loose and the tie valueless.

This is probably the reason why there were so few American creosoted ties shown at the Exhibition of Railroad Appliances in 1883, and the few that were there had been treated to at least 2 gallons of oil to the cubic foot. If I am not correct, I would ask what has become of the thousands that have been treated in the past 30 years in this country, where we use no chairs under the rails?

I have here one of a lot of ties treated by a Mr. Pelton some years since for the Chicago, Rock Island & Pacific Company, and put in the track near Englewood, Ill. It was taken up in May, 1883, to be shown at the Chicago Exposition of that year. These ties were treated in 1872 by what is known as the Seely process, and although they contained but little oil (less than 4 lbs. to the cubic foot), they were sound, so far as examined by me, where they came in contact with the ground, but commenced to decay (so I was told) under the rail as soon as the oil wore off, and not before.

If a sufficient quantity of oil is used to impregnate the ties to a considerable depth at point of contact with the rail (which means for oil 50 cents, or 6 gallons to the tie, and this applies to soft woods only, and not to oak), a good result would be obtained; otherwise, a chair must be used.

If you will show me one tie that has served a good purpose, I will convince you that it was treated to, at least, 6 gallons of oil, or a chair had been used. Not but what a much less quantity would preserve it from decay, if it were placed in the ground as a post, and undisturbed; but should you remove the oil at the ground line—it matters not to what extent, so that the untreated timber is exposed, you will find your creosoting of little value, and this is the experience of all.

Mr. J. W. Putnam, of New Orleans, in a letter to the Chairman of the Committee on Preservation of Timber of the American Society of Civil Engineers, says: "With reference to creosoting, wherever the coating is broken, and the air, with its dust, allowed to come in contact with the untreated wood, decay follows, and extends in each direction from the opening," and he is but one of the many who make this or similar statements.

The Burnettized ties on the Chicago, Rock Island & Pacific Railway, near Englewood—and, so far as I have examined, those on other roads also, where the work was well done—were sound under the rail, but decayed where they came in contact with the ground. Mr. Alexander, in his report of March 23, 1882, to Mr. Hugh Riddle, then President of the Rock Island Company, says: "I have made a careful examination of the Burnettized hemlock ties we laid in the main track just west of Englewood in November, 1866, last summer, and found at least 75 per cent. of them still in the track, and, in my opinion, in such a state of preservation that they will be serviceable for two or three years longer. Some 5 or 6 of these ties were taken out of track, and found to be sound and solid in the center, and only decayed to the depth of ½ to ¾ in. on the surface and sides. The rail has not worn into these hemlock ties to any greater extent than would have occurred with oak, and they hold a spike fully as well as the oak tie. The pine and cedar ties that were Burnettized at the same time have worn out in the 15 years' service, and have disappeared. The tamarack have held out about the same as the hemlock." Continuing, he says: "My experience is that untreated hemlock ties decay first in the center or heart, when the spike becomes loose and the tie crumbles; but these treated ties are sound in the center, which shows that where the chloride of zinc is not washed out, the wood is in a perfect state of preservation."

I saw these ties a short time after they were taken up, and examined those remaining in the track in June, 1883 (they had then been down over 17 years), and found them to be sound under the rail, with hardly an exception. I also had the sound wood from several of these ties analyzed, and found them to contain from 0.05 to 0.14 per cent. of chloride of zinc to weight of the wood when dry.

Again, in the same report (March 23, 1882), Mr. Alexander says: "In 1872, we laid in second track, east of Washington Heights, about 5,000 hemlock ties that were subjected to the creosoting process. These ties I do not believe to have been thoroughly treated. They seemed to be tolerably sound at the bottom, but are badly decayed on the surface, and the rail wears into them to a much greater extent than it does into those that were treated with chloride of zinc. There is probably not more than from 30 to 50 per cent. of these creosoted ties now in track, and these will, no doubt, all be taken out this summer.

I examined these ties, or what there was left of them, in June, 1883, finding few then in the track, but was fortunate, however, in finding several hundred that had just been taken up and piled along the track.

If I am correct, what can be expected of creosoted ties with but 6 to 10 lbs. of oil to the cubic foot, if used, as they are in this country, in direct contact with the rail, and what must we do to get best results in the preservation of our ties? Use a chair, as in England, or open, porous woods, and inject 50 to 75 cents' worth of oil into each tie; or will a double treatment, first with dead-oil and then with chloride of zinc, answer the purpose—the dead-oil to preserve the outer or exposed parts, which it will do, and the zinc chloride the central portions, which the oil does not penetrate to any considerable extent in our most desirable woods? So far as my observations and experiments go, I am satisfied that time will demonstrate that dead-oil and chloride of zinc, injected into ties and timber as proposed, will give the best results for money invested, and where dense woods are used, especially for ties, the best result, without regard to cost.

You may say that the old way of creosoting closed the pores, thereby keeping out moisture. Dead-oil will not keep moisture in or out of wood, like paint, tar or pitch, for any considerable time. Moisture will not enter a creosoted tie above the surface of the water surrounding it, or without pressure; neither will it enter, except under same conditions, where the fiber is oiled. This being the case, your ties, under most conditions, will remain dry, and the zinc chloride should be protected.

Again, you seldom see decay in wood, the fiber of which has once been covered with dead-oil to such an extent as to be seen by the eye. The zinc-creosote process will, as I said before, distribute one-half or less oil in every part penetrated by the greater quantity when injected in the old way, and in such quantities as can be readily seen.

You may say: Would it not be better to first inject the chloride, and then the dead-oil? If the treatment were reversed, you would have to remove a portion of the moisture before the oil could be injected. Wood being one of our best non-conductors of heat, the process would be tedious, and timber or ties would be more or less injured by the long-continued application of the heat required to evaporate sufficient moisture. In fact, the only cheap and practical way would be to air, dry or stack the timber until sufficient moisture has evaporated, and then apply the oil. I do not believe there would be anything gained by so doing, and it would add greatly to the cost.

With reference to the treatment of piling with dead-oil, as protection against the teredo, the old way is to inject all the oil the timber will take (which depends on the piles being more or less dry and the kind of wood operated on), from one to three gallons to the cubic foot. The object of the zinc-creosote process is to economize in the quantity of oil used and nothing more, and consists in first injecting, say, two-thirds (one-half may be found to answer) of the quantity used in the old way, and then, by substituting some other fluid for the oil, as chloride of zinc, air or water, by pressure, compress or force the two-thirds previously injected solidly to the center, which leaves the two ends—the one in the mud or ground, the other above water—with their fibers virtually painted with the dead-oil, while the center of the pile or that portion in the water is as well treated and contains as much oil as would be the case if the whole quantity used had been oil. I would prefer an antiseptic for the second injection, as it would help to preserve that portion above water from decay.

Iron and Steel Production in 1856 and 1886.

(From the *Bulletin* of the American Iron & Steel Association.)

THE following tables were contributed by James M. Swank to the special report on the Mineral Resources of the United States, to be made in 1887 by David T. Day, Chief of the Division of Mining Statistics and Technology of the United States Geological Survey:

PRODUCTION OF IRON AND STEEL IN 1886 COMPARED WITH 1856.

The following table, compiled from the records of the American Iron & Steel Association, gives for comparison the production of some of the leading articles of

iron and steel in 1856 and 1886 in all the grand divisions of the United States. While not comprehensive of the whole range of our iron and steel industries it is complete for the products mentioned. This table shows very clearly the relative growth of the different grand divisions in the manufacture of iron and steel in the last 30 years, which takes us back to four years before the civil war:

Territorial Divisions.		Net tons of 2,000 lbs., except nails.				
		Pig iron.	Rolled iron including iron nail plate and iron rails.	Nails. Kegs of 100 lbs.	Rails of iron and steel.	Blooms from pig, scrap and iron ore.
New England	1856	34,051	78,989	560,600	20,015	6,776
	1886	32.574	99,952	516,749	19,683	175
Middle States	1856	614,593	366,542	1,021,709	124,708	63,790
	1886	3,684,793	1,373.312	2,948,420	1,175,878	36,985
Southern States	1856	143,184	70,601	217,168	12,869	19,619
	1886	875,179	156,801	1,550,941	4,990	4,734
Western States	1856	119,370	41,718	25,872	2,070	1,517
	1886	1,757,739	606,438	2,868,317	580,155	15
Far West'n States	1856	.....	.....	.....	.....	.....
	1886	15,043	47,119	276,546	11,895	.....
Total	1856	911,698	557,850	1,824,749	159,662	91,702*
	1886	6,365,328	2,283,622	8,160,973	1,792,601	41,909

* Including 7,000 gross tons sold direct in bars from the bloomaries and about 14,000 gross tons hammered into bars, axles and anchors by the forges, leaving 68,182 net tons as the total quantity of blooms going into rolling mills.

All the rails made in 1856, namely, 159,662 net tons, were iron rails, while all those made in 1886, namely, 1,792,601 net tons, were steel rails, except only 23,679 net tons of iron rails. During the period covered by these 30 years we built up an iron-rail industry which, in 1872, produced 905,930 net tons of iron rails, and when iron rails had served their day we built up a steel-rail industry which, in 1886, produced 1,768,922 net tons of steel rails. This change from iron to steel rails is one of the most remarkable events in our history.

It will be seen that the manufacture of iron and steel in the United States is a widely extended industry and one which is eminently national in its character. Every grand division of the country is represented in the foregoing table—the Middle States leading, followed in order by the Western States, the Southern States, New England and the Far Western States and Territories.

OUR PRODUCTION OF IRON AND STEEL COMPARED WITH THAT OF OTHER COUNTRIES.

While the foregoing statistics show the wonderful progress of our country in the manufacture of iron and steel in recent years, the commanding position which it has attained as an iron and steel manufacturing country is best shown by a comparison of its achievements with those of other countries.

The following table gives the world's production of pig iron and steel in the most recent years for which statistics are available. English tons of 2,240 lbs. are used in giving the statistics of Great Britain, the United States, Russia and other countries, and metric tons of 2,204 lbs. for all the Continental countries of Europe except Russia. As the difference between the gross ton and the metric ton is so trifling it is not necessary to change official figures:

Countries.	Pig iron.		Steel.	
	Years.	Tons.	Years.	Tons.
Great Britain	1886	6,870,665	1886	2,364,670
United States	1886	5,683,329	1886	2,562,502
Germany and Luxemburg	1886	3,489,231	1886	1,360,620
France	1886	1,507,850	1886	466,913
Belgium	1886	697,119	1886	139,215
Austria and Hungary	1886	726,835	1886	256,023
Russia	1882	498,400	1882	225,140
Sweden	1885	464,737	1885	80,550
Spain	1883	139,920	1886	15,000
Italy	1884	18,405	1884	3,450
Other countries (estimated)	1886	150,000	1886	30,000
Total	.....	20,246,482	.....	7,504,083
Percentage of the U. S.	.....	28	.....	34

This table places the United States first in the production of steel, and second only to Great Britain in the production of pig iron. We may add that it is also the first country in the production of rolled iron. In 1886, Great Britain rolled 1,616,701 gross tons of puddled iron, a much larger quantity than any other European country, while in the same year the United States rolled 2,038,948 gross tons, or 422,247 tons more than Great Britain. We did not, however, pass our great rival in the production of steel until last year, this circumstance alone justifying the designation of 1886 as a remarkable year for the American iron trade. In that year we made 197,832 gross tons more steel than Great Britain.

The United States is shown by the table to be the producer of 28 per cent. of the world's annual output of pig iron, and of 34 per cent. of its anuual output of steel. This prominence must astonish the reader. But our prominence in the production of iron and steel gives less occasion for astonishment than our undoubted pre-eminence as consumers of iron and steel. We are the first country in the world in the consumption of pig iron, manufactured iron and steel. As has already been shown, we annually import from foreign countries, and particularly from Great Britain, large quantities of iron and steel in all forms, which we consume in addition to the products of our own iron and steel works. Our exports of iron and steel do not amount to 1 per cent. of our total production; hence, virtually all the iron and steel that we produce and import is consumed within our own borders.

THE WORLD'S PRODUCTION OF PIG IRON.

From the most reliable information that is obtainable we have compiled the following table of the world's production of pig iron at various periods since the close of the last century, with which we end our present summary of iron and steel statistics.

Years.	Gross tons.	Years.	Gross tons.	Years.	Gross tons.
1800	825,000	1870	11,900,000	1879	13,930,000
1830	1,825,000	1871	12,500,000	1880	17,950,000
1850	4,750,000	1872	13,925,000	1881	19,400,000
1856	7,000,000	1873	14,675,000	1882	20,750,000
1865	9,250,000	1874	13,500,000	1883	21,000,000
1866	9,300,000	1875	13,075,000	1884	19,475,000
1867	9,850,000	1876	13,475,000	1885	19,100,000
1868	10,400,000	1877	13,675,000	1886	20,246,482
1869	11,575,000	1878	13,925,000		

No exhibit could more clearly and effectually show the progress which the civilized world has made in the nineteenth century in the use of iron and steel. We know that the nations of antiquity made but little iron and steel, and there is no reason to believe that prior to the close of the last century the nations of modern times made as much iron and steel annually by all processes of manufacture as they then made of pig iron. The world has, therefore, as our table shows, increased its production of iron in 86 years of the present century more than twenty-fold. Its increased production of steel in the same period has been relatively much greater.

RAILROAD SAFETY APPLIANCES.

(From the London *Engineering*.)

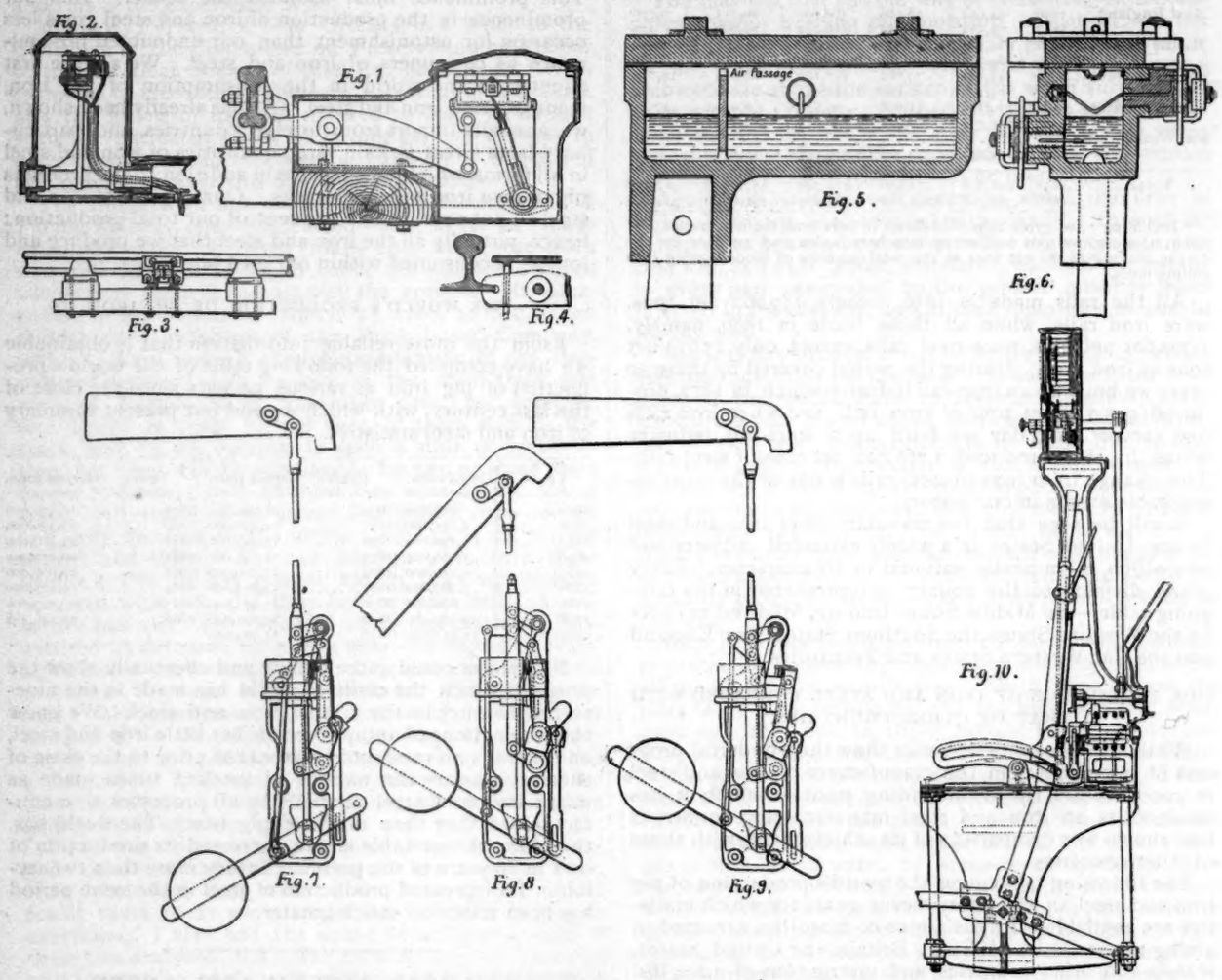
THE security afforded to railroad traveling by the block and interlocking systems is so great that it throws into high relief the occasional accidents which still occur. These are almost always traced to the human element of the system, and are shown to result either from carelessness or from mistakes. If the regulations of the companies were always carried out perfectly, and if men never gave way to indolence nor lost their accuracy of perception and presence of mind, these accidents would be confined to cases arising from the failure of some part of the train or of the permanent way. But there are so many "ifs" in the chain that it is certain to give way at times, the wonder being that it serves its purpose as well as it does.

The mechanical and electrical arrangements in signaling operate so satisfactorily that many have tried to extend them, and to eliminate the men altogether. But no

scheme of this kind has ever been propounded which a railroad engineer could be tempted to try, for although the present apparatus works well, yet no one would dare to trust it without constant supervision, and if the comparatively simple appliances which have been brought to their present state by years cannot be implicitly relied on, it follows that the more complex arrangement needed to enable trains to send their own indications would be sure to fail sooner or later. It may be confidently assumed, therefore, that the signalman is in no danger of being superseded by mechanical appliances for many years to come, and that any improvements which are introduced for the purpose of preventing him from lapsing into error will be designed rather to oblige him to fulfil his duties than to perform them for him. The block system is carried out on the hypothesis that the signalman has to perform a certain series of operations with military regularity, not exercising any option or judgment in the matter, and this feature needs to be kept in view in seeking to render it still more certain. At present a part of the series of acts which is needed for the passing of a train through a section, takes place in the mind of the man in charge; he receives a notification from an adjacent cabin requesting information, or ordering him to give a certain signal, and if he replies correctly or acts upon the instructions, all is well. But if not, a fearful accident may ensue, due not to any fault or weakness of the system, but to the agency by which it is carried out. If the apparatus were so constructed that on a man being asked a question from the adjoining cabin, he could give no answer except the correct one, and on receiving an order he could carry out no operation except that desired, then the human element would be so environed by checks and guards that it would be pulled up sharply if it diverged from the correct path, and all the harm it could do would be to delay the traffic by excess of caution.

An invention has lately been perfected by Messrs. Saxby & Farmer, of Kilburn, London, and is now on view at No. 31 Parliament Street, Westminster, designed to give increased security to our railway system in three ways. Firstly, it renders the working of the signals dependent upon the position and motion of the train, putting them up behind it when it enters a section (should the man neglect to do so) and making it impossible for them to be taken off until the train had gone out of the section. Secondly, it necessitates the conjoint action of the men at each end of a section to take off the signal at the entrance, this action having to be repeated for every train, while either man can put the signal to danger.

RAIL CONTACT MAKER.

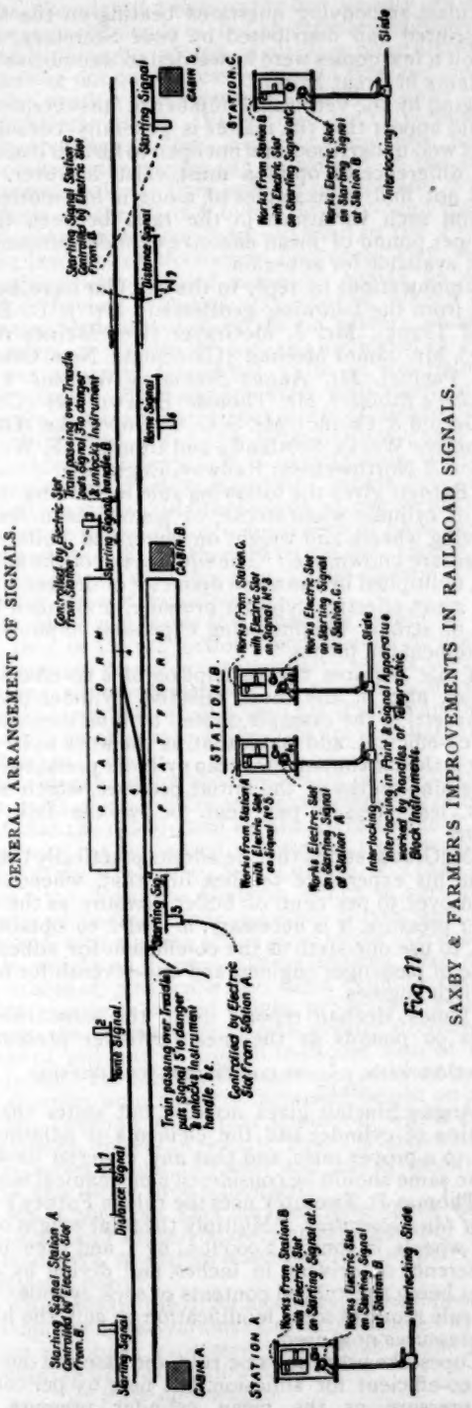


ELECTRIC SLOT APPARATUS.

SAXBY & FARMER'S IMPROVEMENTS IN RAILROAD SIGNALS.

The two principal apparatus by which these ends are attained are an electrical treadle (figs. 1 to 6) and an electric slot (figs. 7 to 9). Fig. 10 shows the general arrangement of interlocking the block instruments with the point and signal levers when such interlocking is adopted, and fig. 11 is a diagram of an ordinary through station and shows the general arrangement of signals, block instruments, etc. Treadles of all kinds have been tried before; those acting mechanically soon get put out of order by the heavy and constant shocks to which they are subject, while the electrical ones suffer from the displacement of

the line, which either brings the contacts into constant connection, or removes them so far apart that they fail to meet when required. The problem of their construction does not appear particularly difficult at first sight, but the long list of failures which have taken place is evidence that the traffic imposes conditions which cannot be easily met. Messrs. Saxby & Farmer have avoided



GENERAL ARRANGEMENT OF SIGNALS.

Fig. 11.

SAXBY & FARMER'S IMPROVEMENTS IN RAILROAD SIGNALS.

all the inconveniences resulting from changes of level by the use of a fluid medium—mercury—as one of the electric conductors. This is contained in a rectangular box, and over the center of its surface the contact point is placed. Now, if the box be inclined to one end or the other, the center of the fluid surface always keeps at the same height, and stands at the same distance from the terminal. If the box be shaken, however, the fluid surface breaks into waves, and the crest of one of these breaking against the contact wire (fig. 6) completes the circuit and sends a current to the cabin. In the longitudinal section of the box (fig. 5) there is shown a diaphragm with a space above and below it for the circulation of air and mercury. This diaphragm is interposed because without it there is always a hollow in the rippled surface of the mercury in the center of the box, and no matter how violent the vibrations, the mercury will never meet the wire and complete the circuit. Now, as it is absolutely essential that the wire should occupy this position, the diaphragm is introduced to break the natural arrangement of the waves and produce a crest under the wire.

The general arrangement of the treadle is clearly shown in figs. 1 and 3. A short piece of timber is bolted across two sleepers parallel to the rail. On this timber is fixed a cast-iron box. In this box is pivoted a lever, connected at its short end with the rail. If the rail be of bull-head section the connection is made as in fig. 1, and if it be flat-footed as in fig. 4. The long end of the lever is connected by a link with the mercury box, which in turn is pivoted by a foot-piece to the outer casting. When a train passes over the treadle the deflection of the rail depresses the lever and imparts a greatly magnified fore-and-aft rocking motion to the mercury box, causing the fluid to rush backward and forward, and make repeated and ample contacts with the wire above it. The electric conductors enter through the lower pivot; one is connected through an insulated bush to the contact wire, while the other is fastened to the mercury box, which is itself insulated from the framing. The entire arrangement is most ingenious, while at the same time its simplicity guarantees it from nearly every chance of derangement. A treadle of this kind has been on the London & Northwestern Railway at Kilburn for 18 months without attention, and has registered in Messrs. Saxby & Farmer's works the passage of all the trains which pass that station. In Russia, the line connecting St. Petersburg with Gatschina is provided with these treadles, which have worked perfectly all through the severe winter.

It will be evident that a treadle such as this provides an essential feature in any system in which the passage of a train is to check or supplement the action of the signalman. If a treadle be placed a little distance past each signal, it will send an electric current which may be utilized in various ways. For instance, by means of an electric "slot," the current may put the signal the train has just passed to "danger." The term "electric slot" is intelligible to those acquainted with signaling appliances, but it is not descriptive, and is further not accurate. It arose in this way: when it is desired that a signal shall not be lowered without the concurrence of two signalmen, it is the custom to hold the arm up by two counterweighted levers, each working in a slot in a rod connected to the arm. If either arm be lifted singly it merely moves up in its slot, since the weight of the other is sufficient to hold up the arm, and no effect is produced. But if both be raised the signal-arm drops. Apparatus of this kind has been made in many forms, more or less complicated, but they have all been known as "slots," and now the same name is applied to electric apparatus which is designed to enforce concurrent action from two sources before a signal can be set to "line clear." It is possible that both actions may be electric, or that one may be electric and one mechanical, or even that more than two agencies may be employed in the working of a slot; but, however that may be, either of the agencies can set the signal to "danger" independent of the other. Messrs. Saxby & Farmer's slot is both mechanical and electrical; the former part is worked by the signalman in the adjacent cabin, while the latter is operated either by the treadle to raise the signal to danger, or by the man in the next cabin to allow it to be lowered. The slot is shown in figs. 7, 8 and 9. The wire from the cabin lever is attached to the weighted lever, and works it in the usual way. This lever is connected by a link to the rod which depends from the signal-arm, but the link does not take hold of the rod directly. It is pivoted to a cross-lever or beam, which at its opposite end is connected to the armature of an elec-

tro-magnet. Now, if the armature be against the poles of the magnet, and the current be flowing when the man pulls the wire, the beam will pivot on its right-hand end, and the rod will be raised and the signal lowered (fig. 8). But, if there be no current flowing, the center of the beam, as the point of greatest resistance, becomes the pivot, and instead of the rod rising the sole effect of the signalman's effort is to carry the armature away from the magnet and rock the beam to no purpose (fig. 9). Thus, it needs that the current be flowing before the man can lower the signal, and it is further required that the signal lever in the cabin shall be first placed in the danger position in order to bring the armature within reach of the attraction of the magnet. When the signal is down it can be released either by the action of the man who lowered it or by interrupting the electric current. This latter office can be performed by the electric treadle or by the signalman in the next cabin. In the former case, when the train has proceeded (say) 100 yards past the semaphore, it passes over the treadle and sends a current from a local battery (the one which works the slot) through a relay. This breaks the circuit to the slot, and causes the arm immediately to rise to "danger," blocking the line automatically behind the train. But this action does not in any way relieve the signalman, for, if he prefers to let the train work the signal, he must move back his lever to raise the armature before he can give "line clear" again, and thus he has to perform all his accustomed operations.

The treadle has also an office to fulfill as regards the instruments in the cabin, but, in order to avoid complication, we will now describe this in connection with the treadle at the entrance of the section. The train having set the signal behind it, as we have already explained, travels on until it enters the next station, when it passes over another treadle; this raises the corresponding signal, and, at the same time, sends a current into the cabin to unlock the instrument by which the man had given "line clear" to the previous cabin. After he had signaled "line clear" he had moved his handle to "line blocked," where it became securely locked so as to render it impossible for him to send "line clear" until the train had passed over the treadle and released the handle. When this has occurred, the man is free to act as circumstances require. If requested he can send another "line clear" to admit the next train, or he can put over his handle to the opposite side, and thus, unlocking his points and signals, fig. 10 (supposing his cabin to be fitted with interlocking gear), he can permit shunting to be done. But once he has given "line clear," he can do nothing further with his instrument until a train has passed over his treadle; by this means all chance of his forgetting that there is a train in the section is entirely done away with. The train in possession of the line commands the situation, for until it passes out the man at the entrance cannot obtain permission to admit another, and neither can he do so on his own responsibility, for the same current that gives him "line clear" also operates the electric slot, and without it the signal cannot be lowered.

It will be seen that the three parts of the apparatus which we have been describing are more or less independent of each other, that is, one part can be applied without the others. For instance, the treadle can be set to lock the present instruments if a slight modification be made in the latter. Or the electric slot can be operated by the present instruments. Or the slot and the treadle can be used together. Consequently, on existing lines the present apparatus may be preserved and only so much of the new introduced as the circumstances require. Perfect safety is attained by using the whole, for then the signalman is attended, as it were, by an invisible companion who makes no sign as long as matters go right, but on the smallest infraction of the established routine steps in to prevent the error and obliges the man to correct it. If the treadle be dispensed with there still remains the safe-guard that the signal at the entrance of a section cannot be lowered until permission is obtained, and that this permission is revoked and the signal automatically raised before any switching can be done in the section.

Proportions of Locomotive Cylinders.

THE following report was presented to the Master Mechanics' Association at the St. Paul convention by the Committee on Proportions of Locomotive Cylinders, composed of Messrs. Charles Blackwell, F. L. Wanklyn and T. E. Barnett:

Circulars embodying questions bearing on the subject were printed and distributed by your Secretary, and in addition a few copies were forwarded to locomotive superintendents in Great Britain.

Judging by the very small number of answers received, it would appear that the matter is generally considered a subject well understood and not open to further discussion. Much difference of opinion must exist, however, or we should not find in examples of modern locomotive construction such variations in the ratio between tractive power per pound of mean effective cylinder pressure, and weight available for adhesion.

Communications in reply to the circular have been received from the following gentlemen: Mr. J. D. Barnett (Grand Trunk), Mr. J. McGrayel (Des Moines & Fort Dodge), Mr. James Meehan (Cincinnati, New Orleans & Texas Pacific), Mr. Angus Sinclair (*National Car & Locomotive Builder*), Mr. Thomas B. Twombly (Chicago, Rock Island & Pacific), Mr. S. G. G. Copestake (Glasgow Locomotive Works, Scotland), and from Mr. F. W. Webb (London & Northwestern Railway, England).

Mr. Barnett gives the following rule for finding the diameter of cylinder when stroke of piston, mean diameter of driving wheels and weight on same, also boiler steam pressure, are known, viz.: "The square root of the adhesive power, multiplied by the mean diameter of drivers, divided by the mean effective cylinder pressure, multiplied by the length of stroke, weights being expressed in pounds and measurements in inches."

This rule requires the assumption of a co-efficient for adhesion, also of the mean effective cylinder pressure. Mr. Barnett, in the example quoted by him, uses one-fifth as the co-efficient, and states that, as the work to be provided for is the maximum, the mean cylinder pressure should be fully nine-tenths of the initial pressure, which should be not less then 7 per cent. below the full boiler pressure.

Mr. McGrayel states that he adopts practically the same rule, but his experience teaches him that, when using a fraction over 50 per cent. of boiler pressure as the mean cylinder pressure, it is necessary, in order to obtain good results, to use one-sixth as the co-efficient for adhesion in the case of passenger engines, and one-seventh for freight and switch engines.

Mr. James Meehan reports using the same rule, but assumes 90 pounds as the mean cylinder pressure, in conjunction with $\frac{1}{6.17}$ as co-efficient for adhesion.

Mr. Angus Sinclair gives no rule, but states that the proportion of cylinder and the elements of adhesion are subject to a proper ratio, and that any material deviation from the same should be considered a mechanical blunder.

Mr. Thomas B. Twombly uses the rule in Forney's *Catechism of the Locomotive*. "Multiply the total weight on the driving wheels, in tons of 2,000 lbs., by 5, and then by the circumference of drivers, in inches, and divide by 4, the quotient being the cubical contents of each cylinder."

This rule requires some modification to suit the higher boiler pressures now used.

Mr. Copestake uses the same rule, and assumes one-fifth as the co-efficient for adhesion, but uses 63 per cent. of boiler pressure as the mean cylinder pressure. He makes no allowance for wear of tires and takes the diameter of wheels over the tires when new.

Mr. F. W. Webb has no fixed rule, but in ordinary practice adopts a 24-in. stroke of piston, and arranges the diameter of cylinders so that the tractive power at starting, with full boiler pressure, does not exceed the adhesive power under the most favorable circumstances.

Mr. Barnett considers that no deviation should be made from the rule, whether the engine in question be for passen-

ger, freight or switching service. Mr. McGrayel recommends the co-efficient for adhesion to be one-sixth for passenger and one-seventh for freight and switching engines. Mr. Copestake says that the rule should apply to both passenger and freight engines, but in the case of switching engines, the stroke may be longer in proportion to the diameter of the cylinder. Mr. Webb states that he adopts the same rule for both passenger and freight engines.

In reply to question No. 5 of circular, Mr. Barnett states: "When tractive force is in excess of adhesive weight, the results, although not necessarily bad, usually are so, if the engine is in the hands of but an ordinary engineer; as the engine slipping her wheels so easily, is often allowed to do so, causing not only excessive wear of tires and machinery, but also wasting the steam and throwing away the fuel. Nevertheless, within the narrow limits permissible in locomotive design, the larger the cylinder the more economically the engine can be worked in the matter of fuel consumption. This was the opinion and practice of M. Marie, of the Paris & Lyons Railway—and the experiments then carried out (and recorded in the *Proceedings* of the Institute of Mechanical Engineers, May, 1884) with an eight-wheels coupled passenger engine, on mountain service, having cylinders 19¼ × 26 in., wheels 49⅝ in. diameter, with about 58,000 lbs. on drivers, show a consumption of 2.88 lbs. of fuel per indicated H. P. or 3.27 lbs. per actual H. P. and but 30 lbs. of wet steam per H. P. developed. This was achieved with steam at 128 lbs. pressure, cutting off at 19 per cent. of stroke—weight of train 163½ tons, speed 17½ miles per hour, on a continuous grade of 1 in 53½. It is questionable whether such expensive construction is justified where fuel is cheap." He further states: "In other words, an engine having a boiler pressure of 150 lbs., driving wheels of 66 in. mean diameter, and a weight on them of 66,200 lbs., should not have cylinders larger than 17 × 24 in., unless economy of fuel and water is of great importance."

Mr. McGrayel states that when the weight on drivers is less than in the proportion recommended by him, he finds that engines do not give satisfactory results, on account of slipping, which necessitates use of sand, and consequent wear of tires; and when wheels are slipping and are caught on sand, crank pins and side-rods are very liable to be bent or broken.

Mr. Meehan states that the weight on the driving wheels is a point of great influence on the efficiency of the engine, and that the rule quoted by him gives splendid results, as shown by the decreased tire wear. On entering the service of the Cincinnati, New Orleans & Texas Pacific, he found the Northern Division, which is very hilly, with grades of 60 ft. per mile, 6-degree curves, and 27 tunnels, stocked with engines which were of the average character as to weight on drivers. These engines were superseded by others of practically the same cylinder capacity, but with greatly increased weight per driving axle, and as a result, the Roadmaster reports greatly decreased surface wear of rail, and he himself finds the wear of tires much reduced. He believes this has been attained by reduction of slipping, on account of increased weight on drivers.

Mr. Twombly states that engines in which the ratio of weight on drivers to tractive power is above the average, give better results, the wear and tear of machinery being less, and life of tires prolonged.

Mr. Copestake says he generally takes the ratio of cylinder and adhesive power about equal, but if anything, would give an excess, not exceeding 10 per cent., to the adhesive power.

To illustrate the difference in cylinder dimensions, when calculated by the various rules recommended by the gentlemen who have expressed their views on the subject, the following figures are of interest:

Data { Passenger engine. Stroke of piston, 26 in. Mean diameter of driving wheels, 61 in. Weight on drivers, 60,000 lbs. Boiler pressure, 160 lbs.

Barnett .... $\sqrt{\frac{\frac{60,000}{5}\times 61}{134\times 26}}$ = 14.5 in. diameter of cylinder.

McGrayel... $\sqrt{\frac{\frac{60,000}{6}\times 61}{85\times 26}}$ = 16.6 in. diameter of cylinder.

Meehan .... $\sqrt{\frac{\frac{60,000}{6.17}\times 63}{90\times 26}}$ = 16.2 in. diameter of cylinder.

Twombly ... $\sqrt{\frac{\frac{60,000}{2,000}\times 5\times 198}{4\times 26}}$ = 16.9 in. diameter of cylinder.

Copestake .. $\sqrt{\frac{\frac{60,000}{5}\times 63}{101\times 26}}$ = 16.9 in. diameter of cylinder.

Webb..... $\sqrt{\frac{\frac{60,000}{3.7}\times 63}{160\times 26}}$ = 15.67 in. diameter of cylinder.

Proposed rule ..... $\sqrt{\frac{\frac{60,000}{4}\times 61}{136\times 26}}$ = 16.1 in. diameter of cylinder.

In the consideration of this subject, one has to deal with two indefinite quantities, namely, the mean effective steam pressure in the cylinders and the co-efficient of adhesion, and both of these have to be assumed before any calculation can be proceeded with.

The first, or mean effective cylinder pressure, is of course, primarily governed by the boiler pressure, and is secondarily subject to alteration by point of cut-off and speed—it is assumed that the engine is worked with the throttle wide open, and that the steam passages are of proper dimensions, otherwise the pressure will be influenced by these causes.

Few railroads are free from grades which necessitate engines being worked, to a greater or less extent, nearly up to their ultimate capacity, and in the event of starting on such grades, as well as from stations generally, of being worked full power; hence it appears proper that the mean effective cylinder pressure should be placed sufficiently high to cover such cases, and your Committee are of opinion that 85 per cent. of the boiler pressure be considered the mean effective cylinder pressure in the formula.

The second indefinite quantity, or the co-efficient of adhesion, varies as the condition of the surface of the rail changes, and, according to Molesworth, from $\frac{1}{3.7}$ to $\frac{1}{11.2}$, the former being due to a perfectly clean and dry rail; the latter to a slightly moistened or frosted rail. In different parts of the world it is doubtless possible to find places where the average co-efficient for the year will vary to such an extent as to warrant special allowance being made to suit the circumstances; but in the United States it may be safely stated that exceptional climatic peculiarities, sufficient to justify any material deviation from a standard rule, do not exist.

As passenger engines are worked so as to produce a mean effective cylinder pressure of 85 per cent. of the boiler pressure for a very limited fraction of their total mileage, it would appear not improper to use the co-efficient one-fourth, or that due to a dry rail, for calculating the proportions of passenger engines.

Freight engines being worked to their ultimate capacity to a very much greater extent than passenger engines, it would be consistent to increase the co-efficient to say $\frac{1}{4.25}$, and in the case of switching engines, generally worked full stroke, a co-efficient of $\frac{1}{4.5}$ would be required to obviate the excessive use of sand, to prevent slipping on the more or less greasy rail generally encountered in yards where this class of engine is employed.

An inspection of the tabular statement herewith, shows that among engines of recent construction very great variations in their relative tractive power and adhesive weight exist.

In the case of American passenger engines, and using the formula recommended by your Committee, it is found that the New York, Lake Erie & Western Mogul engine, built by the Baldwin Company, has an excess of adhesive weight of 26,600 lbs., or 38.7 per cent.

The eight-wheeled engine built by the Mason Works shows an excess of over 12,400 lbs., or 22.3 per cent; while the Lake Shore and the Old Colony eight-wheeled engines are deficient in the same respect to the extent of 6,500 lbs., or 9.2 and 9.5 per cent. respectively.

Among foreign passenger engines, the Belgian State locomotive has an excess of adhesive weight of over 20,000 lbs., or about 46.5 per cent.; the New South Wales Mogul an excess of nearly 16,000 lbs., or 25.2 per cent.; while the Great Northern express engines, with 91½-in. driving wheels, are deficient to the extent of 12,600 lbs., or over 24.8 per cent.

Among freight engines of American build, the variations are not so great. The Union Pacific Wootten consolidation engine has an excess of 18,900 lbs., or 21.8 per cent., the Baltimore & Ohio Mogul an excess of 12,500 lbs., or 16.7 per cent.; while the Baldwin "Decapod" shows a deficiency of 18,300 lbs., or 12.5 per cent.

Of foreign freight locomotives, the six-wheels coupled engine of the Great Eastern Railway has an excess of 16,200 lbs., or 24.6 per cent., while the Dübs consolidated engine, built for Brazil, has a deficiency of 14,900 lbs., or nearly 14.3 per cent.

Of switching engines, the Brooks six-wheeled switcher has a deficiency of 13,900 lbs., or 17.4 per cent.

Your Committee recommend for general purposes, the use of the following formula:

$$\frac{d^2 \times S \times P \times 0.85 \times C}{D} = W$$

D = Diameter over tires when half worn.
d = Diameter of cylinder.
S = Stroke of piston.
P = Boiler pressure.
W = Weight on driving wheels.

C = Co-efficient for adhesion $\begin{cases} \frac{1}{4} & \text{for passenger engines.} \\ \frac{1}{4.25} & \text{for freight engines.} \\ \frac{1}{4.5} & \text{for switching engines.} \end{cases}$

Should extreme economy in fuel and water consumption be considered imperative, and of greater importance

CYLINDER CAPACITY AND ADHESIVE WEIGHT OF VARIOUS MODERN LOCOMOTIVES.

Accompanying Report on "Proportions of Locomotive Cylinders."

PASSENGER ENGINES.

Name of Railroad or Maker.	Cylinder. Diam.	Cylinder. Stroke.	Driving wheels, diameter over new tires.	Tractive power per 1 lb. M. E. C. P.	Boiler pressure.	Weight on driving wheels. Actual.	Calculated.	Excess.	Deficiency.
	In.	In.	In.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Belgian State	17½	24	79	90.8	142	64,300	43,900	20,400	.....
New York Central	17	24	70	101.3	143	52,200	49,800	2,400	.....
Chicago, Burlington & Quincy	17	24	69	102.8	140	53,600	48,900	4,700	.....
Chicago, Rock Island & Pacific	17	24	66¾	105.0	150	52,500	53,300	.....	800
Brooks—1883	17	24	67	105 9	140	48,000	50,400	.....	2,400
Great Northern (England)	18½	28	91½	106.6	140	38,100	50,700	.....	12,600
New York, Providence & Boston	18	24	72	110.3	180	72,000	67,500	4,500	.....
Northern Pacific	17	24	62	114.6	140	51,400	54,500	.....	100
Chicago, Burlington & Quincy	18	24	69	115.2	140	54,500	54,800	.....	300
Lake Shore & Michigan Southern	18	24	69	115.2	180	64,000	70,500	.....	6,500
Old Colony	18	24	69	115.2	175	61,700	68,200	.....	6,500
Mason	18	24	68	116.9	140	68,000	55,600	12,400	.....
Cincinnati, New Orleans & Texas Pacific	18	24	68	116.9	140	60,000	55,600	4,400	.....
Chicago, Rock Island & Pacific	18	24	66¾	117.4	150	55,000	59,600	.....	4,600
Caledonian	19	26	78	120.3	160	68,200	65,400	2,800	.....
Glasgow & Southwestern	17½	26	73½	120.3	140	62,000	57,300	4,700	.....
Great Eastern	18	24	64	124.4	140	65,000	59,200	5,800	.....
Grand Trunk (tank)	17	24	56	127.3	140	57,200	60,600	.....	3,400
Union Pacific	18	26	63	138.1	140	61,000	65,700	.....	4,700
New South Wales	18	26	60½	142.8	130	79,000	63,100	15,900	.....
Lehigh Valley	20	24	68½	143.3	130	73,400	63,100	10,300	.....
New York, Lake Erie & Western	20	24	68	144.4	140	95,300	68,700	26,600	.....
Philadelphia & Reading	21	22	68½	144.8	140	71,900	68,900	3.000	.....
Lehigh Valley	20	24	62	158.7	160	90,000	86,300	3,700	.....

FREIGHT ENGINES.

Great Eastern (England)	17½	24	58	130.1	140	82,000	65,800	26,200	.....
Brooks—Mogul	18	24	55¾	143.3	140	72,500	72,500	.....	.....
Baltimore & Ohio	19	24	60	148.1	140	87,400	74,900	12,500	.....
Brooks—Ten-wheeler	19	24	55¾	159.7	140	73,100	80,800	.....	7,700
Canadian Pacific	19	22	51	160 5	160	90,900	92,800	.....	1,900
Union Pacific	20	24	58	171.4	140	105,600	86,700	18,900	.....
Louisville & Nashville	20	24	51	193.9	150	97,000	104,700	.....	7,700
Norfolk & Western	20	24	50	197.9	140	96,000	100,100	.....	4,100
Pennsylvania	20	24	50	197.9	140	100,600	100,100	500	.....
Northern Pacific	20	24	49	202.1	140	97,000	102,200	.....	5,200
Dübs (for Brazil)	20	24	48	206.5	140	89,500	104,400	.....	14,900
St. Gothard	20.47	24	46	226.0	149	114,030	122,000	.....	8,000
Southern Pacific	21	36	57	286.0	130	121,000	134,300	.....	12,700
Decapod (Baldwin)	22	26	45	289.3	140	128,000	146,300	.....	18,300
Johnston's (Four-cylinder)	22	18	57	314.6	140	140,000	158,800	.....	18,800

SWITCHING ENGINES.

Brooks	17	24	48	149 2	140	66,000	79,900	.....	13.900
Union Pacific	18	26	52	168.5	140	87,700	90,200	.....	2,500
Norfolk & Western	19	24	50	178 6	140	94,900	95 600	.....	700

Note.—In calculating weight for adhesion, the M. E. C. P. is assumed to be 85 per cent. of boiler pressure, and the co-efficient for passenger, freight and switching engines, $\frac{1}{4}$, $\frac{1}{4.25}$ and $\frac{1}{4.5}$, respectively.

than additional cost of superheaters and steam-jacketed cylinders and maintenance of same, a considerable increase of cylinder power would be admissible, so as to allow the average work to be performed with a correspondingly earlier cut-off and greater ratio of expansion.

The unsatisfactory results, however, obtained with the ordinary link motion from the wire-drawing of steam, when cut off much earlier than at 25 per cent. of the stroke, point to the desirability of using some other type of valve motion, when the extreme practice above referred to is contemplated.

THE NEW WARSHIPS.

AT the Navy Department in Washington, on August 8 bids were opened for the building of three cruisers—No. 1, the *Newark*, and Nos. 4 and 5—and two gunboats—Nos. 3 and 4. The designs for these vessels were described, and those for the cruisers illustrated, in the JOURNAL for July, pages 311–315.

Under the terms of the notice given by the Department the proposals were to be in three classes, as follows: Class 1, for the construction of the hull and machinery, including engines, boilers and appurtenances, complete in all respects, in accordance with the plans and specifications provided by the Secretary of the Navy. Class 2, for the construction of the hull and machinery, including engines, boilers and appurtenances, complete in all respects, in accordance with the plans and specifications provided by the contractor. But no such proposal was to be considered unless accompanied by full and complete plans and specifications of such hull and machinery, and a satisfactory guarantee of the results of the same if adopted. Class 3, for the construction of the hull according to the plans and specifications provided by the Secretary of the Navy, the contractor to put in engines, boilers and appurtenances of any design which he may consider more suitable than those called for by said plans and specifications, not to exceed, however, in weight, nor in the space to be occupied, that allotted in said plans and specifications. But no such proposal was to be considered unless accompanied by full and complete plans and specifications of such proposed engines, boilers and appurtenances, and a satisfactory guarantee of the results of the same if adopted.

The bids received by the Department were as follows:

CRUISER No. 1.—*Newark:*

Cramp & Sons, Philadelphia, Class 3	$1,248,000

CRUISERS NOS. 4 AND 5:

	Each.
Cramp & Sons, Class 1	$1,410,000
Cramp & Sons, Class 2, with 3-in. protective deck	1,325,000
Cramp & Sons, Class 2, with 4-in. protective deck	1,350,000
Cramp & Sons, Class 3	1,405,000
Union Iron Works, San Francisco	1,428,000

GUNBOATS NOS. 3 AND 4:

Cramp & Sons, Philadelphia, Class 1	495,000
N. F. Palmer, Jr. & Co., New York, Class 1	490,000

The three cruisers must be completed within 24 months and the two gunboats within 18 months from the time of signing the contract.

N. F. Palmer, Jr. & Co. represented the yard of John Roach & Sons, at Chester, Pa., and, for the machinery, the Quintard Iron Works, New York.

The awards made by the Navy Department under these bids were announced August 15, and were as follows:

Cruiser No. 1—*Newark*—to Cramp & Sons for their bid, $1,248,000.

Cruiser No. 4 to Cramp & Sons under their bid of Class 2 (they to furnish plans) for $1,350,000.

Cruiser No. 5 to the Union Iron Works, San Francisco, for $1,428,000.

Gunboats Nos. 3 and 4 to N. F. Palmer, Jr. & Co., for $490,000 each.

In submitting the bids to the President, the Secretary of the Navy writes: "I have compared with the aid of the Chiefs of the Bureaus of Construction and Steam Engineering, the various plans, and in accordance with their advice I respectfully recommend that one ship be built upon the Department's plans, and that for the other one the bid of William Cramp & Sons, for $1,350,000 be accepted. With this later bid original designs are submitted. These plans differ somewhat from those of the Department. The proposed ship is larger in tonnage, with thicker protective deck, lighter in construction in parts and stronger in others. A cheaper mode of construction is adopted in some respects, but none but approved practices are employed. The hull designed by the Bureau is more expensive to build, but which is the better on the whole no one can, at the present time, safely predict. I think there is every advantage in building both, and I so recommend."

We may here briefly repeat that the *Newark* is to be a cruiser with a maximum speed of 18 knots. Her main battery is to consist of twelve 6-in. breech-loading rifles, all on center-pivot mounts. She is to have twin screws, to be 310 ft. long on the water line, 49 ft. 1¾ in. extreme breadth, 18 ft. 9 in. mean draft. She is to have machinery of 6,000 I. H. P. with natural draft and 8,500 with forced draft. She is to have a bark rig spreading 1,200 ft. of plain sail. This vessel is to have a double bottom extending through 129 ft. of the length.

The description of the twin cruisers is in most respects similar in every detail with that of the *Newark*. The exceptions are that they are to have machinery of 7,500 I. H. P. under forced draft. The speed is to be 19 knots, and the rig that of a three-masted schooner spreading 5,400 square feet of sail. Their armament is also to consist of main batteries of twelve 6-in. breech-loading rifles.

Gunboats Nos. 3 and 4 are to be 1,700 tons each. They are twin-screw vessels, having a length on the load line of 230 ft., an extreme beam of 36 ft. and a displacement at 14 ft. of 1,700 tons. The machinery is estimated to indicate 2,200 H. P. with natural and 3,300 with forced draft. There are to be two independent compound engines placed in separate compartments. The cylinders will be 29 in. and 52 in. diameter and 30-in. stroke. The speed is stated at 16 knots.

Should the vessels on trial fall below the required speed, the contractors are to forfeit $50,000 for each quarter knot deficient; on the other hand, they will receive $50,000 over the contract price for each quarter knot gained over the required speed.

FIRST-CLASS TORPEDO-BOAT.

The Navy Department has issued a call for bids for a first-class torpedo-boat, complete with the exception of torpedoes and their appendages. The boat must be of modern design, must be built of steel and provided with twin screws and with engines which shall give the highest attainable speed, 22 knots being fixed as a standard. The cost of the boat is not to exceed $90,000, but the builder will receive a premium if the speed is found to exceed 22 knots. Bidders must submit full drawings and specifications, with complete description, showing the kind, power and economy of the engines and boilers to be used; also all the arrangements and fittings of the vessel. Bids must be all in by noon of Tuesday, November 1 next.

THE ARMORED BATTLE-SHIP.

The Secretary of the Navy has appointed a board of officers, consisting of Chief Constructor T. D. Tilson as senior member and President, Engineer-in-Chief George J. Melville, Captain George Brown, Assistant Naval Constructor Francis T. Bowles and Assistant Naval Constructor Lewis Nixon, to convene at such time and place as may be designated by the presiding officer of the board for the purpose of examining and carefully considering the plans for the armored battle-ship furnished by the Barrow Shipbuilding Company, and reporting to the Department the probable cost, exclusive of armament, of constructing such vessel in accordance with said plans, the armor to be furnished by the Bethlehem Iron Company, of Bethlehem, Pa., under the contract of June 1, 1887.

In accordance with the terms offered by the Department, the Barrow Shipbuilding Company will receive $15,000 for the design for this ship. The further sum of

$6,900 has been agreed upon as the price to be paid for full working drawings and plans for the construction of the vessel.

LIST OF SHIPS AUTHORIZED.

We repeat here a table showing the present condition of matters in relation to the vessels which are to form the new Navy, and the construction of which has so far been authorized by Congress:

	Tons disp.	Chief battery.	Conditions.
MONITORS:			
Amphitrite.....	3,800	4 10-in.	To be completed.
Monadnock.....	3,800	4 10-in.	" "
Terror.....	3,800	4 10-in.	" "
Miantonomah....	3,800	4 10-in.	" "
Puritan.....	6,000	4 10-in.	" "
BATTLE-SHIP:			
Armored battle-ship	6,000	2 12-in. 6 6-in.	Designs adopted.
CRUISERS:			
Atlanta.....	3,000	2 8-in. 4 6-in.	In commission.
Boston.....	3,000	2 8-in. 4 6-in.	Nearly ready.
Chicago.....	4,500	4 8-in. 6 6-in.	Nearly ready.
Charleston.....	3,730	2 10-in. 6 6-in.	Building, Union Iron Works.
Baltimore.....	4,400	4 8-in. 6 6-in.	Building, Cramp & Sons.
Newark.....	4,000	12 6-in.	Contract let, Cramp & Sons.
No. 4.....	4,000	12 6-in.	Contract let, Cramp & Sons.
No. 5.....	4,000	12 6-in.	Contract let, Union Iron Works
Armored cruiser.	6,000	4 10-in. 6 6-in.	Designs under consideration.
GUNBOATS:			
Dolphin.....	1,300	1 6-in.	Complete.
No. 1.....	1,700	6 6-in.	Building, Union Iron Works.
No. 2.....	900	4 6-in.	Building, Columbian I. Wks. Balt.
No. 3.....	1,700	6 6-in.	Contract let, Palmer & Co.
No. 4.....	1,700	6 6-in.	Contract let, Palmer & Co.
TORPEDO-BOATS, ETC.:			
Stiletto.....	.....	.....	Purchased.
First-class, No. 1	.....	.....	Bids called for.
Pneumatic dynamite gunboat..	....	3 P. D.	Building, Cramp & Sons.

The total number of vessels whose building is authorized is thus 5 monitors, 1 battle-ship, 9 cruisers (one heavily armored), 5 gunboats, 1 pneumatic dynamite gunboat and 2 torpedo-boats; a total of 23 vessels, large and small.

THE "ATLANTA'S" GUN-CARRIAGES.

The report of the board (Captain F. M. Ramsay, Commander C. F. Goodrich, Naval Constructor Philip Hichborn, Lieutenant A. R. Conden and Assistant Naval Constructor Lewis Nixon) to the Secretary of the Navy on the guns and gun-carriages of the *Atlanta* is dated July 29, and is as follows:

In obedience to the Department's order of July 22, the Board convened on board the *Atlanta*, Newport, R. I., July 25, and made a careful examination of the ship, guns, carriages and fittings and of the damage sustained during the recent target practice, as reported by board of officers ordered by the commanding officer of the *Atlanta*. The board proceeded to sea on the morning of July 25, but were prevented from firing the guns by a heavy fog which prevailed throughout the day. The ship was again taken to sea on the morning of July 27 and the guns were fired. No deficiencies were noted in the guns themselves, other than a slight sticking of the breech plug in 6-in. B. L. R. No. 5 (this disappeared during the firing), some difficulty in the management of the lock 6-in. B. L. R. No. 4, caused by slight upsetting of the firing-pin, and the bending of the extractor in 6-pounder R. F. No. 5.

The recoil and counter-recoil of the 8 and 6-in. guns were easy and satisfactory, except at the second fire of the 8-in. B. L. R. No. 1, when the gun remained in. (This was readily run out with a tackle.) The action of the carriage of 8-in. B. L. R. No. 1, at the first fire, was due to want of strength in the clips and clip circles, and at the second fire to want of sufficient bearing and securing of the deck socket. It is believed that had the deck socket held the carriage would not have been disabled by the giving way of the clips. The training gear, steam and hand, was uninjured; the gun was readily trained when run out to place. The action of the after 6 in. shifting gun No. 4 was satisfactory, notwithstanding that the front clips had a play of half an inch. The action of the broadside carriages of 6-in. guns Nos. 5 and 18 was satisfactory, except the breaking of clips, the starting of the copper rivets in the clip circles, and the wood screws in the training circles. It is believed from the action of the carriage of 6-in. B. L. R. No. 5, when the clips were removed, that the carriages can be safely used without clips. The clips, however, give additional security and steadiness to the carriage, and assist the pivot and socket in bearing the shock of the discharge. The firing of the 6-pounder R. F. guns developed a weakness in one leg of the cage-mount of No. 4, due to imperfect workmanship, and also the necessity of locking nuts on the bolts that secure the mounts to the ports. The tower mounts of the 3-pounder R. F. guns are unsatisfactory. They cannot be moved with facility; the line of sight of the gun is obstructed at ranges beyond 1,600 yards, and the guns cannot be safely used as now fitted. For this reason 3-pounder R. F. No. 3 was not fired. The tripod mounts of the 1-pounder R. F. guns need stronger holding-down arrangements. The tower mounts of the 47-millimeter R. C. are like those of the 3-pounder R. F. guns, and have the same defects. The shelf and the trolly mounts of the 37 mm. in the tops are satisfactory. Careful observation of the effect of the firing upon the hull of the vessel failed to develop any damage other than the breaking of the cast-steel port sills and the starting of some light woodwork. The shock of discharge was slight on the berth deck, and observers there were unable to observe which 6-in. gun had been fired. The deck, hull and fittings, with the exception of the port sills, hinges to superstructure doors and vegetable lockers and some of the light woodwork, have every appearance of strength and ability to endure the strain of continuous firing of the guns. The blast of the forward 8-in. gun, when fired abaft the starboard beam, will not permit the crews of the starboard 3-pounder R. F. and 1-pounder R. F. to remain at their guns. When the after 8-in. gun is fired forward of the port beam the crews of the after 47 mm. R. C. and of the port after 1-pounder R. F. cannot remain at their guns. When the forward 6-in. shifting-gun is fired on the port bow, or directly ahead, the crew of forward 8-in. gun cannot remain at their places. When the after 6-in. shifting-gun is fired on the starboard quarter, or directly aft, the crew of the after 8-in. gun cannot remain at their gun. The inability to fire parts of the secondary battery under certain conditions is due to the great arc of fire given to the 8-in. guns. This can hardly be called a defect. It is thought that a screen can be placed between the 8 and 6-in. guns, which will enable them to be worked together forward or aft.

The pivot socket of the 8-in. carriage should have a broader bearing surface and should be rigidly bolted to the steel deck and to the framework of the ship in such manner as to distribute the strain over a larger area. The clips and clip circles of the 8-in. and 6-in. carriage should be made of steel. The clips should have larger bearing surfaces, and should be shaped to fit the circle. The circle should have double flanges and be bolted (not riveted) on each flange to the steel deck. There should be no appreciable play between the clips and the circles. All bolts used in the battery fittings should have the nuts locked.

The clip rail of the tower mount should be altered to fit the mount. This change will make the compressors effective and allow the guns to be used with safety.

The port sills should be replaced by heavier sills made of the best quality of malleable cast-steel.

The plan of testing the hull, guns and fittings of the *Atlanta*, arranged by the Board, contemplated a more extended use of the main battery, but the weakness developed in the port sills and in the sockets of the 8-in. carriages rendered further firing inadvisable.

The English Naval Review.

(From the London *Engineer*.)

WITH all that took place at the great Naval Review, held at Spithead on Saturday, July 23, the world has been made more or less familiar by the daily press. It would be waste of time did we attempt to tell the story over again. We have failed, however, to find in the columns of our contemporaries certain deductions which admit of being drawn from the spectacle. No doubt they did not suggest themselves to the non-professional mind. We propose to fill the gap and direct attention to points connected with the construction of warships, which have not, as we think, received the attention they deserve. Let it not be supposed, however, that we are going to fight over again the battle of ships and guns, or to discuss the relative merits of various types of armor. Nor shall we say anything of stability, or ramming, or steering powers. The questions we propose to discuss have indeed little or nothing to do with any of these things. They have, as a rule, been entirely ignored. To see the modern warship anchored at Spithead sufficed to force these questions on the attention of any thoughtful man, who, knowing something of naval warfare and the conditions under which it will be carried on, was at the same time unwedded to any particular system of construction or method of fighting.

Let us consider what is the purpose for which such a ship as, let us say, the *Inflexible* has been constructed. This vessel has a displacement of nearly 12,000 tons, her main engines indicate between 7,000 and 8,000 H. P., and she carries 10 guns, four of them very nearly the heaviest afloat. She is besides fully fitted with torpedo gear. The whole object and purpose of this vessel is to carry her 80-ton guns and torpedoes from place to place as they may be required. She has considerable speed, first, because she may at any time be wanted in a hurry in some special place; secondly, that if an enemy tries to run away she may be able to catch her; and lastly, that if she has herself to run away, being attacked by an overwhelming force, she may be able to make the attempt with some prospect of success. The be-all and end-all of her existence is, however, to carry 4 mighty guns, and to enable them to be discharged with as much effect as possible against an enemy. Regarded from this point of view, it will be seen that everything becomes subordinate to the guns, and, of course, the torpedoes. Now it is impossible, we think, to look at such a ship without feeling that everything is not subordinate to the guns, but that, on the contrary, the guns are subordinate to many things. Let us for the moment leave torpedoes on one side, and consider what would be the best way to make the guns efficient. At the outset it appears that it is a policy of doubtful wisdom to put all four of such extremely expensive eggs in one basket, and that four ships, each carrying one 80-ton gun would be better than one ship carrying four guns of this weight. This point, however, we shall not urge; but, retaining our four guns, does it not appear that these weapons, if to be carried in turrets, ought to be so carried that the ship will present the least possible mark to the enemy, and that the structure of the ship above the water-line should be as simple and straightforward as possible? In one word, Ericsson's *Monitor* above water supplies the *beau ideal* of what a warship carrying heavy guns ought to be. We say "above water" advisedly, because there were many and grave defects in the underwater portion of the *Monitor* type, as elaborated in the United States, which should not be copied. The perfect warship, then, would be a vessel with her upper deck not raised many feet above the water-line, and nothing projecting above that deck save the two turrets carrying the guns and the funnel. If it be conceded that the object of the life of a warship is to fight, and that fighting involves the carrying of heavy guns from place to place, then it will be admitted that our definition of the perfect warship is sound. Of course if our proposition is disputed on the ground that in a warship everything is not subordinate to guns, a large question for discussion may be opened. Let us suppose for the moment that the soundness of our proposition is granted, and see how far the modern turret ship complies with it. It was only necessary to pass down the lines at Spithead to see that such ships as the *Devastation*, *Inflexible*, *Ajax*, etc., do not comply with it at all. We have in them first the low deck and the turrets, but above these rises a huge structure, weighing a great many tons, and employed as a promenade deck, if we may so use the words. In addition, there are dozens of great ventilators, needed to take foul air out of the ship and pass air into her, to say nothing of supplying her furnaces. Of boats we need not speak. They may, perhaps, be regarded as necessary evils. It is quite impossible for those who have not been on board a modern turret-ship to fully realize what a mass of top-hamper, as a sailor would say, she carries, but a very fair idea of it could be got by those who kept their eyes open at the review. May we ask, what would become of all this top-hamper in a naval engagement. It has often been stated that deck-houses, to use an euphuism, would all be blown to bits during the first few minutes, and that their loss would entail no trouble. This we venture to doubt. That the hurricane deck, etc., would be smashed up by quick-firing shell guns in a very short time is quite true; but can anyone assert that the consequences might not be disastrous? We may take it for granted that no lives would be lost, for the crew would be withdrawn below when the ship went into action; but is it not possible that a turret might easily be rendered useless by a mass of heavy ironwork falling on and jamming it? But this is not all. If the great ventilators are essential to the working of the ship, what will occur when these ventilators are crushed up and practically ruined? The funnels are to a certain extent protected by armor-plating near the base, but above they are easily destroyed. What would be the result of this destruction? The furnaces depend for their draught, it may be urged, on fans—not on a chimney. Quite so; but all the fans in existence could not help a ship if her funnel was choked below with fragments of itself dropped from above. Naval architects do all that lies in their power to make a ship impregnable as far as the hull is concerned; and they then build up on the top of this hull a mighty structure of decks and houses and ventilators and funnels, and we know not what, and think that all is well. This view we cannot take. We believe that in this much neglected superstructure lies an important element of danger, and that the truth has not been recognized before, simply because attention has been diverted altogether to other aspects of the warship question.

We have no doubt but that it will be urged that these deck structures are essential; that they cannot be done without, that they are needed to provide accommodation for the crew and as means of navigating the ships. This is quite possible; but, so much the worse. It may be pointed out, however, that by saving the weight of these things the ship might be made to float a little higher in the water, and so provide a little more accommodation for the crew below. It does seem strange that in a ship of 12,000 tons it is impossible to find room for 450 men without resorting to deck-houses, and the unprejudiced mind begins to think that if naval architects consulted with naval men a little more it might be possible to arrive at a compromise which would end in reducing the intolerable amount of top-hamper now being carried, and would secure means of ventilation without the necessity for the vast wind sails which now disfigure our men-of-war, especially the fast ships So much for one lesson taught, we think, by the review. Now for another.

Those who were fortunate, or shall we say unfortunate, enough to see the review from the great Indian trooper *Tamar* saw that she was steadily followed from Southampton Docks by a craft which, looked on from the great height of the *Tamar's* taffrail, more resembled in hue and shape, but certainly not in speed, a huge slug than anything else. This was the submarine torpedo-boat, the *Nordenfelt*, which has already been pretty fully described and illustrated in our pages. The *Tamar* got out of dock late, as she had to give way to the *Orontes* and the *Himalaya*, and she did not waste time in steaming to Portsmouth. She is a fast ship too, and returning to Southampton in the evening, she very easily and hand-

somely beat the *Orontes*. But on the run down to Portsmouth the *Nordenfelt* just kept the position with regard to the troopship that she liked best. She was not nearly submerged; yet the target she presented was extremely small. Coming bows on 200 yards or so in the wake of the *Tamar*, little could be seen but an upheaved mass of water. Unlike torpedo-boats, which, when going at speed, lift their bows out of the sea, the *Nordenfelt* keeps on an even keel, and raises in front of her a curious wave, which is rifle proof and probably proof even against machine-guns, because the solid mass of water deflects bullets upwards at such an angle that they clear the hull. The *Nordenfelt* appeared to be the very incarnation of destructive power. There was not one of the magnificent and costly men-of-war reviewed by her Majesty that could do anything to avert destruction by the *Nordenfelt*, if this destruction were contemplated, save take to her screws as fast as she could. At a distance of a mile the boat, when *à fleur d'eau*—that is to say, with only her little conning-tower out of the water—is invisible; when within a couple of hundred yards we do not believe she would be detected, save by chance, if there was a little sea on; at night, the chances of her being found by torpedo guard-boats would be extremely small. She could thus run quite close up to a ship without availing herself fully of her submarine powers, and her chances of getting away unhurt, after discharging her torpedoes, would be very good. But she could approach within a mile of an iron-clad at anchor; take her bearings accurately and then go down and proceed under water until she had run the requisite distance—she could, if in any doubt, come nearly to the top for a moment to permit the steersman to see where he was precisely, and then go down without being detected, or, if detected, injured—and immediately afterward deliver a blow which would send a great ironclad to the bottom. The *Nordenfelt* has rendered, we think, naval operations against forts and harbors nearly impossible. No commander dare lie near a harbor from which a submarine boat could be despatched to blow up his ship. The one chance remaining is that ships may be rendered torpedo proof, and how that is to be done remains to be seen.

During the review the *Nordenfelt* lay near the *Tamar*. In the evening she weighed her anchor and steamed back to Southampton, where, we understand, Government trials will be carried out with her in a short time. Events follow each other with rapidity in the Nineteenth Century. We have already seen the British Navy entirely reconstructed on principles which were not dreamed of in 1856. It is possible that a very few years will suffice to see it remodeled once more, and our readers may rest assured that, if this be the case, the influence of the *Nordenfelt* will be manifested in that remodeling.

The New Light Artillery Guns and Carriages.

(From the Springfield, Mass., *Republican*.)

A MODEL for a machine-gun carriage has just been completed at the United States Armory in Springfield. The carriage is the invention of Colonel Buffington, as was the artillery carriage adopted by the Government last year, and is ingeniously constructed, promising to revolutionize this feature of modern warfare. The carriage furnishes a complete protection to the gunners, and will render the men who are working it as safe as they would be inside an iron-clad. Contrary to what would naturally be expected from such a contrivance, it will present a graceful and imposing appearance. The features of the carriage are a huge semi-circular concave shield rising from the axle, a steel apron, which drops from the axle to the ground, a steel disk which covers each wheel and the hollow iron axle and trail. The most noticeable thing about the carriage is the great half-luna shield of armor metal, which rises from the axle, and through which the muzzle of the gun projects. The front of the axle is curved on a line with a great circle passed through the sphere of which the shield is a quarter. The half-shield is made of the toughest steel, 0.15 in. in thickness, and is bolted to the front edge of the axle. This is of sufficient resistance to afford protection from any bullet shot from a distance of 200 yards or over, and a machine gun cannot be used to advantage in closer combat. A circular hole is cut in front of the shield, which will allow the muzzle of the gun to turn as far in any direction as it could if the shield were not used. Of course, if the shield were left with this aperture uncovered the gunner would still be exposed, but to remedy this two large circular shields, about the size of the ordinary Greek shield, are riveted one on each side of the aperture in the main shield, so that they can be made to revolve on the rivet which fastens them. A hole is cut in the edge of each of these smaller shields so that it covers the gun all but about an inch on each side. Thus, when the gun is raised or lowered, the shields revolve and the aperture is still covered. The smaller shields are also made to run in a track to allow for the movements of the gun from side to side. No weight is carried on the muzzle, and the freedom of the sweep is not in the least impaired.

It was said that the outside or smaller shields cover the gun excepting about an inch at each side. This allows for the sighting of the gun, but, at the same time, renders the protection to the gunner incomplete, so that a thimble is made to slip over the muzzle of the gun inside the shield. This thimble will carry a flange on it sufficiently wide to make up for the space left open by the smaller shields, and it will have in it a slot, which can be turned toward and away from the sight, as occasion requires. The axle is what is called a box-beam axle and is hollow; it thus furnishes room for a closet on each side, which are shut by steel doors. These, with a similar closet in the hollow steel trail, gives room for 1,200 cartridges, or as many as are fired in an ordinary battle. The axle, although hollow, is stronger than a common steel and wooden axle. A T-axle runs along on the bottom of the box-beam axle, and a steel apron is fastened to this which reaches to the ground, but can be swung back and strapped to the trail when the carriage is drawn by the limber. The apron is made of the same metal as the shields. The wheels will also be covered by disks of the same metal, and when these are all in use the gunner will be behind a complete armor. Any or all of these protections can be taken off and laid aside at will. The large shield being spherically curved, a ball which strikes it in any place but the center will be made to glance off, and if it strikes the center it will come in contact with two steel plates made by the lapping of the two shields, unless it strikes the muzzle of the gun. The carriage can be used with any machine gun. The models of the shields are made of wood, but the trail and body are of steel. A steel shield will be made as soon as Colonel Buffington finds a kind of steel which is tough enough. It is reported that a Kentucky blacksmith has discovered a new way of tempering metal and that he will present the method to the Government. Colonel Buffington is waiting to see what it turns out to be. The lines of the whole carriage are symmetrical and it reminds one, with its dome shaped shield, of a Roman chariot.

The Captive Kite-Balloon.

(E. Douglas Archibald, in *Nature*.)

IT has always been an objection to the extensive use of captive balloons for scientific or military purposes, that a wind of moderate strength suffices not merely to depress them considerably from the vertical, but to cause them to jerk, rotate and oscillate vertically and horizontally in such a manner as to render them either partially ineffective or totally useless.

During the recent military manœuvres at Dover, it was stated that the captive balloon under the charge of Major Templer was not allowed to ascend beyond the shelter of the surrounding downs, owing to the strong wind then prevailing. It was thus *hors de combat* as far as the enemy was concerned, and this seems to be a common experience of military balloonists.

The jerking, as a balloon after a freshening of the wind suddenly reaches the end of its tether, is, I am told by an

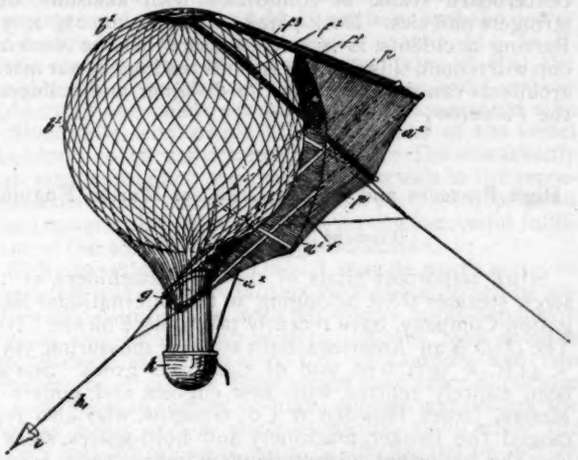
experienced member of the Balloon Corps, very trying to the nerves, while the rotation on its axis is a serious obstacle to steady observation.

The depression of a captive balloon in a wind of any sensible strength is also more than most persons would imagine, and as the velocity of the wind generally increases with the height (very rapidly for the first few hundred feet), while the buoyancy of the balloon, owing to several causes, diminishes, this condition becomes more pronounced at the higher levels.

The depression is obviously due to the fact that a captive balloon, as at present employed, can only be secured at its *base*, and thus the normal component of the wind is resolved in a downward direction, pressing the balloon toward the earth. If the fastening could be made two-thirds of the way up its side, this normal component could be resolved in an upward direction, and utilized so as to add to the elevating power of the balloon. The fragile nature of the balloon fabric, however, renders it impossible to do this except by interposing a kite-surface between it and the wind.

All the preceding defects are remedied and several positive advantages are gained by attaching a balloon to a kite in the manner indicated in the accompanying diagram.

In this diagram the captive kite-balloon is shown, the letters of reference being as follows: a^1, octagonal kite,



THE CAPTIVE KITE-BALLOON.

with frame of four pieces of bamboo; b^1, spherical balloon; f, covering of kite (preferably silk); p, extra or top hood; $f^1 f^2$, etc., bands connecting kite and hood with top of balloon; g, ring connecting lower end of kite with the converging net cords of balloon; h, tail of cones (i); l^1, earth-line connected with kite, one branch passing through a pulley to the car (k).

The advantages claimed are: The addition of the kite, with the fastening at the side instead of the base, counteracts the depression produced by the wind, and not only raises its own weight, but even in a light anti-cyclonic breeze elevates the whole apparatus to a higher level than that which could be attained by the balloon alone.

Thus, in an experiment here on Friday, June 10, in the presence of Mr. Eric S. Bruce and others, with a very light wind (I have since ascertained that during the trial the mean velocity at Greenwich, 211 ft. above the sea, with a good exposure for the wind, then northeast, was 12 miles per hour; the present locality was in a valley 260 ft. above sea-level, surrounded by hills, rising 500 ft. above the sea), the balloon, of 113 cub. ft. capacity and with 1,200 ft. of wire out, attained *alone* a mean vertical height of 693 ft., while when attached to a kite of 9 ft. by 7 ft. and the same lengths of wire it kept steadily at 789 ft. The lifting power in the second case was also greatly increased, as shown by the following comparison of the angles of the kite and wire in the two cases:

	Angle of	
	Balloon.	Wire near the ground.
Balloon alone	38°	18°
Balloon with kite	41½°	35°

The lifting power of the balloon with hydrogen was about 5 lbs., the wire weighed about 4 lbs. and the kite 2¼ lbs. The addition of the kite raised 1¼ lbs. more than the balloon could have done alone, with a good deal to spare. It increased the height by 96 ft. and diminished the sag by 13½°.

With the tail (made of self-regulating cones) it completely counteracts the jerky, rotatory, and oscillatory movements of the balloon, by keeping the wire taut and exerting a constant pull on the balloon at its lower extremity.

With the addition of the *top hood*, an essential feature of the combination, the kite shields the balloon fabric from the destructive action of the wind.

The combination can be flown on a much larger percentage of days than the balloon alone.

In a large balloon with car attached the occupant can alter his altitude and azimuth by pulling the lower or side attachment of the kite, and thus extend his area of observation.

With the kite, and except in the rare case of a dead calm, a much smaller balloon is needed to raise a given weight.

The kite portion is portable and easily detachable in the event of a calm.

The use of wire (a suggestion which I owe to Sir William Thomson) greatly increases the strength and lessens the weight of the earth-line.

I arrived at the idea of uniting the two apparatuses while conducting my kite anemometrical observations in 1884, owing to my desire to prevent my kites from coming down suddenly when the wind dropped. I found the balloonists equally desirous of some means for shielding their balloons from damage and keeping them *up* in a *wind*. The kite-balloon satisfies both requirements, and will, I trust, be of use both to scientific as well as military observation.

Fighting Ships.

A CORRESPONDENT of the London *Times* concisely sums up the arguments of the two parties in the controversy in the question of the proper uses and distribution of armor in fighting ships:

One party, including Sir E. Reed and the majority of naval officers, say that the first duty of a ship is to float, therefore side armor should be used to protect the buoyancy and stability of ships intended to take their place in line of battle, otherwise they will certainly be sunk or capsized by the gun fire of their enemies.

The other party, which includes Sir N. Barnaby, Mr. W. H. White and Sir W. Armstrong, say that their opponents overrate the probability of a ship being sunk by gun fire. It was a very rare occurrence even in the old naval wars, when gun fire was the only mode of attack, but now you have, in addition to gun fire, the ram and the locomotive torpedo, both of which will probably play a very important part in future naval battles; side armor renders no protection against either ram or torpedo, and, in order to be effective against modern artillery, it must be of very great thickness; but if constructors insist on carrying side armor of great thickness all round a ship in order to protect her against the one element of artillery fire, it must be remembered that it renders her more liable to destruction by the other two weapons, ram and torpedo, for it is necessary to curtail her speed and handiness, or else give her a feebler armament or less coal-carrying power, and these last four qualities—viz.: speed, handiness, armament and coal endurance—are of vital importance in a modern man-of-war.

The correspondent, who is a captain in the Royal Navy, says that, in his opinion, the power, or rather the probability, of the ram and torpedo, has been overrated; and the power and probability of the recently developed (and still developing) quick-firing gun have been underrated.

The best of ships for fighting purposes must only be compromises; that if you want more speed you must give up some armor protection, or some armament, or some coal; these are the four great qualities which govern the problem, and you may sit down and ring the changes upon how much of each of these you can get into a ship of a given tonnage at a given cost, remembering that,

while your ship is still building, there will in all probability be some inventions and improvements in engines, guns, torpedoes, compound armor, or something else connected with your art, which, if you do not adopt in your ship, will lay her open to be called obsolete before she is ever put in commission, and lay you open to censure by naval officers and professional rivals; and if you do adopt them, you will alter your ship from her original design, making her, perhaps, too deep in the water, and laying yourself open to the censure of professional rivals and party politicians.

The New Yacht "Volunteer."

(From the *Marine Journal.*)

THE new steel sloop yacht *Volunteer* has surprised the yachting fraternity of the United States by beating her rival sisters *Puritan* and *Mayflower* three out of four races, as follows: From New London to Newport, *Volunteer* beat *Puritan* 7 minutes 21 seconds and the *Mayflower* 56 minutes 43 seconds. In the race for the Goelet cup, from Newport to the entrance to Vineyard Sound, *Volunteer* beat *Mayflower* 8 minutes 42 seconds, *Puritan* 10 minutes 53 seconds. In the race from Vineyard Haven to Marblehead, *Volunteer* beat *Mayflower* 2 hours 23 minutes 29 seconds, while the *Puritan* carried away her topmast and was, of course, out of the race.

The *Volunteer's* rough handling of the *Mayflower* in each of these races is sufficient guarantee that she is a faster boat, and if all signs do not fail she will doubtless be chosen to defend America's cup against the *Thistle*.

The contract for the *Volunteer* was signed between General Paine and Pusey & Jones, of Wilmington, Del., April 5. Only 86 days were required to construct the hull. She was launched July 1, and a few days later towed to Boston to receive her spars and fit out at the yard of Geo. Lawley & Son, South Boston.

Below is given a table of elements of the *Volunteer*, as well as those of other famous sloops, now so well known on both sides of the Atlantic:

PARTS OF THE VESSEL.	*Volunteer.*	*Mayflower.*	*Thistle.*	*Galatea.*	*Priscilla.*	*Atlantic.*	*Puritan.*	*Genesta.*
Length over all.....	107	100	106.10	100.6	95	95.1	93	96.5
Length on waterline..	85.10	85	85	86.10	83.3	83.4	81.1	81.6
Beam.....	23	23.6½	20.3	15	22.8	23.10	22.6	15
Beam at waterline....	22	22.3	20	15	22.2	23.2	21.6	15
Depth of hold.....	10	10	14.2	13.3	9.4	10.6	9.6	11.9
Draft.....	10	10	13.8	13.6	9	9.10	9.3	13
Area midship section.	96	92	115	125	92	102	88	115
Mid section from bow	0.60	0.60	.....	.....	0.60	0.64	0.58	.....
Mast, deck to hounds.	65	63	62	53	61.9	63	60	52
Topmast.....	48	46	45	47	48	48	44	44.6
Boom.....	84	80	80	73	80	78	76	70
Gaff.....	52	50	50	45	48	48	47	46
Bowsprit outboard...	37	38	38.6	36.6	39.7	38	38	36.6
Spinaker boom.....	70	67	70	65.6	66	70	65	64
Displacement.....	116	110	135	157.6	115	120	102.5	140
Inside ballast.....	10	14	10	6	47	15	12	5
Keel ballast.....	50	37	55	72	.....	47	32	68
Sail area by N. Y. Y. C. rule.....	9,000	8,634	8,880	7,505	8,500	8,100	7,370	7,150

The *Volunteer*, though essentially like the *Mayflower* in body, can be viewed as one step nearer the keel vessel. Built of steel, the garboards have been dropped, and the rocker to the gutter keel-plate has been held along well amidships, so that she will draw 18 in. more than the *Mayflower* along the middle where the ballast will be run into the keel. This will bring about a lower center of weight and also more draft than in the *Mayflower*. In racing trim, the *Volunteer* will draw about 10 ft. 9 in., which is only 2 ft. less draft of water than a regular cutter would require, and probably within 2 ft. 6 in. the same as that of the *Thistle*.

She has the same beam at waterline as the *Mayflower*, though she is about one foot longer. The topsides have, however, less flare, so that the *Volunteer* is not so wide across deck. A minor peculiarity of the *Volunteer* is her clipper stem and the accompanying moderate flare in the harpins, in which respect she is similar to the Scotch *Thistle*. The overhang of the *Volunteer* was intended to be of the fashionable cutter style, but the builders introduced a slight variation, which gives to the extreme after end of the overhang an individual character not found in any other yacht. In rig she will be almost a counterpart of the *Thistle*.

The sail area of the *Volunteer* is larger than that of the *Mayflower*, as will be seen by the foregoing table. The foresail is 5 ft. 9 in. longer on the foot, owing to the overnanging stem. The mainsail is 2 ft. longer on foot. Topsail is larger and spinaker boom 3 ft. longer.

The hull of the *Volunteer* has all the strength combined with lightness of material that the best of steel can produce.

The keel is a gutter plate ¾ in. thick; aft it dovetails into the sternpost, and 10 ft. forward of the centerboard trunk it scarfes to the heel of the forward bar keel turned up into the stem. This piece is 6 × 1¼ in. planed almost to a knife-edge from the forefoot up. Sternpost is 2½ in. thick with the rudder tapered away to ½ in. across its after edge. The frame is of angle steel with reverse angles, spaced 2 ft. Diagonal and bilge stringers and deep brackets stiffen the frame, while fore-and-aft strength is supplied by the forged bed piece and casing of the centerboard trunk in connection with keelsons, deck stringers and ties. Deck plank of white pine, 2½ × 3 in. Barring accidents, it is safe to assert that the *America's* cup will remain this side the Atlantic as long as our marine architects can do as well as the designer and builders of the *Volunteer*.

High Pressure and Forced Draft for Marine Engines.

(From the London *Engineering.*)

SOME important trials of the new machinery of the screw steamer *Ohio*, belonging to the International Navigation Company, have recently taken place on the Clyde. The *Ohio* is an American built steamer measuring 343 ft. × 43 ft. × 34 ft. 6 in., and of 3,325 tons gross. She has been entirely refitted with new engines and boilers by Messrs. James Howden & Co., Glasgow, who also rearranged the bunker, machinery and hold-spaces, so as to give the important advantage of increased cargo accommodation obtainable from the use of their improved machinery, which occupies considerably less space than the engines and boilers of the same power which have been replaced. The new engines are of the triple-expansion type, and the boilers, which are designed for supplying steam of 150 lbs. pressure, are worked on Howden's system of forced draft, which combines increased power with high economy in fuel. The object of the owners in refitting the *Ohio* was to test the capability and economy of this system of forced draft on a sufficient scale to guide them in dealing with steamships of the largest class and great power.

In the refit of the *Ohio* the boilers were designed to work with a very moderate air-pressure, this being sufficient for the power required by the contract. The combined power and economy, however, guaranteed by Messrs. Howden & Co. for the use of their system of forced draft was higher than has hitherto been attempted in any steamship, and sufficient, if attained, to prove the large reduction that could safely be made in the number and size of boilers for the use of the system, and the quantity of coal required to produce a given power. The contract for the refit of the steamer required that 2,100 indicated H. P. (which was the maximum power of the engines removed) should be maintained during the trial on a consumption of 1.25 lbs. of coal per I. H. P. per hour. Originally, the boilers of the *Ohio*, from which this power was produced, were three in number, double-ended, 12 ft. 6 in. in diameter by 17 ft. 6 in. in length, having each 6 furnaces 3 ft. in diameter, or 18 furnaces in all, with an aggregate fire-grate area of 300 sq. ft. The new boilers, fitted with the forced draft, are likewise three in number, but single-ended, 13 ft. in diameter by

11 ft. 2 in. in length, having each 3 furnaces 3 ft. 3 in. in diameter, or 9 furnaces in all, with an aggregate fire-grate area of 112 sq. ft. Air for combustion is supplied to the boilers by one of Messrs. W. H. Allen & Co.'s fans, 5 ft. 6 in. in diameter, driven direct by an engine having a cylinder 7 in. in diameter with stroke of 4 in. The boilers removed had two stokeholds across the ship, one fore and one aft of the boilers, while the new boilers have only one stokehold on the after side. The engines removed have cylinders 57 in. and 90 in. in diameter, by 48 in. stroke, while the new engines have three cylinders 31 in., 46 in. and 72 in. in diameter, respectively, with piston stroke of 51 in.

During the trials the coals were weighed out under the supervision of the officers of the company, who also took the record of speed and other data. After running down Channel for a considerable time, the trial on the coals weighed out began and lasted 4 hours 10 minutes, during which time 10,885 lbs. of Welsh coal were burned, the trial ending with the same revolutions of engines and the same pressure in boilers with which it began. The mean I. H. P. calculated from the mean of seven sets of indicator cards, taken during the trial, and the mean revolutions per minute, found by dividing the total revolutions recorded on the engine counter by the minutes in the period of the trial, amounted to 2,124, thus making the consumption 1.23 lbs. per I. H. P. per hour, and the power per square foot of fire-grate almost exactly 19 I. H. P. While testing the I. H. P. and consumption of coal, the steamer ran to and fro between the Cloch and Cumbrae Lights, and also made several runs on the measured mile at Skelmorlie, from which the mean speed of the vessel was found to be 14.12 knots per hour. The remarkably high results obtained were most satisfactory to the representatives of the owners, and a large party of experts on board congratulated Mr. Howden on the successful fulfilment of the onerous guarantees undertaken.

While speaking of the *Ohio*, it may be worth while to give a few particulars regarding experience gained by another ship-owning firm with Howden's triple-expansion engines and forced-draft system. About nine months ago, Robert MacAndrew & Co., of London, had two steamers built on the Tyne which were exact duplicates of each other in respect of hulls, engines and boilers, the engines being of the triple-expansion type, while the boilers had a working pressure of 160 lbs. per sq. in. At sea, the engines gave out about 600 I. H. P. The steamers run in the same trade, which is between Hamburg and Barcelona. In one steamer the boiler was fitted and is worked with Mr. Howden's forced draft, and the other is worked with natural draft. In both cases, however, the boilers were originally designed for working with natural draft. Messrs. MacAndrew & Co. report, regarding the *Churruca*, one of the steamers, that, after she had worked for seven or eight months as at first fitted, she was supplied with the forced-draft appliances, which enabled her to perform the round voyage from Hamburg to Barcelona and back on 207 tons of coal, while her sister ship, the *Gravina*, under the same conditions, required 264 tons of coal for the same run; so that the saving by using the forced draft was nearly 22 per cent. Howden & Co. are just completing two sets of engines of 1,200 I. H. P. each for MacAndrew & Co., the boilers being arranged for working on the forced-draft system.

The Electric Current as a Means of Increasing and Varying the Tractive Adhesion of Railroad Motors and Other Rolling Contracts.

[American Association for the Advancement of Science. New York meeting of 1887. Paper by Elias E. Ries.]

THE object of this paper is to lay before you the results of some recent experiments in a comparatively new field of operation, but one that, judging from the results already attained, is destined to become of great importance and value in its practical application to various branches of industry.

I say "comparatively new," because the underlying principles involved in the experiments referred to have to a certain extent been employed (in, however, a somewhat restricted sense) for purposes analagous to those that form the basis of this communication.

As indicated by the title, the subject that will occupy our attention is the use of the electric current as a means of increasing and varying the frictional adhesion of rolling contacts and other rubbing surfaces, and it is proposed to show how this effect may be produced both by means of the direct action of the current itself, and by its indirect action through the agency of electro-magnetism.

Probably the first instance in which the electric current was directly employed to vary the amount of friction between two rubbing surfaces was exemplified in Edison's electro-motograph, in which the variations in the strength of a telephonic current caused corresponding variations in friction between a revolving cylinder of moistened chalk and the free end of an adjustable contact arm whose opposite extremity was attached to the diaphragm of the receiving telephone. This device was extremely sensitive to the least changes in current strength, and if it were not for the complication introduced by the revolving cylinder it is very likely that it would to-day be in more general use.

It has also been discovered, more recently, that in the operation of electric railroads, in which the track-rails form part of the circuit, a considerable increase in the tractive adhesion of the driving-wheels is manifested, due to the passage of the return current from the wheels into the track. In the Baltimore & Hampden electric railroad, using the Daft "third-rail" system, this increased tractive adhesion enables the motors to ascend without slipping a long grade of 350 ft. to the mile, drawing two heavily loaded cars, which result, it is claimed, is not attainable by steam or other self-propelling motors of similar weight. In the two instances just cited, the conditions are widely different as regards the nature of the current employed, the mechanical properties of the surfaces in contact and the electrical resistance and working conditions of the respective circuits. In both, however, as clearly demonstrated by the experiments hereinafter referred to, the cause of the increased friction is substantially the same.

In order to ascertain the practical value of the electric current as a means of increasing mechanical friction, and, if possible, to render it commercially and practically useful wherever such additional friction might be desirable, as for example in the transmission of power, etc., a series of experiments were entered into by the author, which, though not yet fully completed, are sufficiently advanced to show that an electric current, when properly applied, is capable of very materially increasing the mechanical friction of rotating bodies, in some cases as much as from 50 to 100 per cent., with a very economical expenditure of current; this increase depending upon the nature of the substances in contact and being capable of being raised by an increased flow of current.

Before entering into a description of the means by which this result is produced, and how it is proposed to apply this method practically to railroad and other purposes it may be well to give a general outline of what has so far been determined. These experiments have shown that the co-efficient of friction between two conducting surfaces is very much increased by the passage therethrough of an electric current of low electro-motive force and large volume, and this is especially noticeable between two rolling surfaces in peripheral contact with each other, or between a rolling and a stationary surface, as in the case of a driving-wheel running upon a railroad rail. This effect increases with the number of ampères of current flowing through the circuit of which the two surfaces form part and is not materially affected by the electromotive force so long as the latter is sufficient to overcome the electrical resistance of the circuit. This increase in frictional adhesion is principally noticeable in iron, steel and other metallic bodies and is probably due to a molecular change in the conducting substances at their point of contact (which is also the point of greatest resistance in the circuit), caused by the heat developed at that point. This heat is ordinarily imperceptible and becomes

apparent only when the current's strength is largely augmented. It is, therefore, possible that a portion of this increased tractive adhesion is due directly to the current itself, aside from its heating effect, although I have not as yet been able to ascertain this definitely. The most economical and efficient results have been obtained by the employment of a transformed current of extremely low electro-motive force (between one-half and one volt), but of very large volume or quantity, this latter being variable at will so as to obtain different degrees of frictional resistance in the substances under observation.

These experiments were originally directed mainly toward an endeavor to increase the tractive adhesion of the driving-wheels of locomotives and other vehicles, and to utilize the electric current for this purpose in such a manner as to render it entirely safe, practical and economical. It will be apparent at once that a method of increasing the tractive power of the present steam locomotives by more than 50 per cent. (without adding to their weight and without injury to the roadbed and wheel tires such as caused by the sand now commonly used) would prove of considerable value, and the same holds true with respect to electrically propelled street-cars, especially as it has been found exceedingly difficult to secure sufficient tractive adhesion on street-railroads during the winter season, as well as at other times, on roads having grades of more than ordinary steepness. As this, therefore, is probably the most important use for this application of the electric current it has been selected for illustrating this paper.

I have here a model car and track arranged to show the equipment and operation of the system as applied to railroad motors. The current in the present instance is one of alternating polarity, which is converted by this transformer into one having the required volume. The electro-motive force of this secondary current is somewhat higher than that necessary. In practice it would be about half a volt. You will notice upon a closer inspection that one of the forward driving-wheels is insulated from its axle, and the transformed current, after passing through a regulating switch under the control of the engineer or driver, goes to this insulated wheel, from which it enters the track-rail, then through the rear pair of driving-wheels and axle to the opposite rail and flows up through the forward uninsulated wheel, from the axle of which it returns by way of a contact brush to the opposite terminal of the secondary coil of the transformer. Thus the current is made to flow *seriatim* through all four of the driving-wheels completing its circuit through that portion of the rails lying between the two axles, and generating a sufficient amount of heat at each point of contact to produce the molecular change before referred to. By means of the regulating switch the engineer can control the amount of current flowing at any time, and can even increase its strength to such an extent in wet or slippery weather as to evaporate any moisture that may adhere to the surface of the rails at the point of contact with the wheels, while the locomotive or motor car is under full speed.

It will be apparent that, inasmuch as the traction circuit moves along with the locomotive and is complete through its driving-wheel base, the track rails in front and rear of the same are at all times entirely free from current, and no danger whatever can occur by coming in contact with the rails between successive motors. Moreover, the potential used in the present arrangement, while sufficient to overcome the extremely low resistance of the moving circuit, is too small to cause an appreciable loss of current from that portion of the rails in the circuit, even under the most unfavorable conditions of the weather. In practice the primary current necessary is preferably generated by a small high-speed alternating dynamo on the locomotive, the current being converted by means of an inductional transformer similar in construction to the one here shown. To avoid the necessity for electrically bridging the rail-joints, a modified arrangement may be employed, in which the electrical connection is made directly with a fixed collar on the forward and rear driving-axles, the current dividing itself in parallel between the two rails in such a manner that if a defective joint exist in the rail at one side the circuit is still complete through the rail on the other, and as the rails usually break joints on opposite sides this arrangement is found very effective. The insulation of the driving-wheels is very effective in either case.

As the amount of additional tractive adhesion produced depends on the quantity of current flowing, rather than upon its pressure, the reason for transforming the current, as described, will be apparent, and its advantages over a direct current of higher tension and less quantity, both from an economical and practical standpoint, will, for this reason, be clear. The amount of heat produced at the point of contact between the wheels and rails is never large enough to injure or otherwise affect them, although it may be quite possible to increase the current sufficiently to produce a very considerable heating effect. The amount of current sent through the traction circuit will, of course, vary with the requirements, and, as the extent to which the resistance to slipping may be increased is very great, this method is likely to prove of considerable value. While, in some cases, the use of such a method of increasing the tractive power of locomotives would be confined to ascending gradients and the movement of exceptionally heavy loads, in others it would prove useful as a constant factor in the work of transportation. In cases like that of the New York Elevated Railroad system, for example, where the traffic during certain hours is much beyond the capacity of the trains, and the structure unable to support the weight of heavier engines, a system like that just described would prove of very great benefit, as it would easily enable the present engines to draw two or three additional cars with far less slipping and loss to motion than is the case when mechanical friction and weight alone is relied upon at a cost for tractive current that is insignificant compared to the advantages gained. Other cases may be cited in which this method of increasing friction will probably be found useful, aside from its application to railroad purposes, but these will naturally suggest themselves and need not be further dwelt upon.

In the course of the experiments above described, another and somewhat different method of increasing the traction of railroad motors has been devised, which is more particularly adapted to electric motors for street railroads, and is intended to be used in connection with a system of electric street railroads now being developed by the author. In this system electro-magnetism provides the means whereby the increase in tractive adhesion is produced, and this result is obtained in an entirely novel manner. Several attempts have heretofore been made to utilize magnetism for this purpose, but apparently without success, chiefly because of the crude and imperfect manner in which most of these attempts have been carried out. The present system owes its efficiency to the formation of a complete and constant closed magnetic circuit, moving with the vehicle and completed through the two driving-axles, wheels and that portion of the track-rails lying between the two pairs of wheels, in a manner similar to that employed in the electrical method before shown. We have here a model of a second motor-car equipped with the apparatus mounted on a section of track and provided with means for measuring the amount of tractive force exerted both with and without the passage of the current.

You will notice that each axle of the motor-car is wound with a helix of insulated wire, the helices in the present instance being divided to permit the attachment to the axles of the motor connections. The helices on both axles are so connected that when energized they induce magnetic lines of force that flow in the same direction through the magnetic circuit. There are, therefore, four points at which the circuit is maintained closed by the rolling wheels, and as the resistance to the lines of force is greatest at these points, the magnetic saturation there is most intense and produces the most effective results just where it is most required. Now, when the battery circuit is closed through the helices, it will be observed that the torque or pull exerted by the motor-car is fully twice that exerted by the motor with the traction circuit open, and by increasing the battery current until the saturation

point of the iron is reached the tractive force is increased as shown by the dynamometer. A large portion of this resistance to the slipping or skidding of the driving-wheels is undoubtedly due to direct magnetic attraction between the wheels and track, this attraction depending upon the degree of magnetic saturation and the relative mass or metal involved, but by far the greater proportion of the increased friction is purely the result of the change in position of the iron molecules due to the well-known action of magnetism, which causes a direct and close interlocking action, so to speak, between the molecules of the two surfaces in contact. This may be illustrated by drawing a very thin knife-blade over the poles of an ordinary electro-magnet, first with the current on and then off.

In the model before you the helices are fixed firmly to and revolve with the axles, the connections being maintained by brushes bearing upon contact rings at each end of the helices. If desired, however, the axles may revolve loosely within the helices, and instead of the latter being connected for cumulative effects, as illustrated, they may be arranged in other ways so as to produce either consequent or opposing magnetic forces, leaving certain portions of the circuit neutral and concentrating the lines of force wherever they may be most desirable. Such a disposition will prove an advantage in some cases.

The amount of current required to obtain this increased adhesion in practice is extremely small, and may be entirely neglected when compared to the great benefit derived. The system is very simple and inexpensive, and the amount of traction secured is entirely within the control of the motor-man as in the electric system. It will be seen that the car here will not, with the traction circuit open, propel itself up hill when one end of the track is raised more than 5 in. above the table, but with the circuit energized, will readily ascend the track as you now see it, with one end about 13 in. above the other in a length of 3 ft., or the equivalent of a 40 per cent. grade, and this could be increased still further if the motor had power enough to propel itself against the force of gravity on a steeper incline, as you will notice the motor adheres very firmly to the track and requires a considerable pull to force it down this grade, whereas with the traction circuit open, it slips down in very short order, notwithstanding the efforts of the driving mechanism to force it up.

The resistance of the helices on this model is less than two ohms, and this will scarcely be exceeded when applied to a full-sized car, the current from two or three cells of secondary battery being probably sufficient to energize them.

The revolutions of the driving-axles are not interfered with in the slightest, the former, because the axle-boxes are outside the path of the lines of force, and the latter, because each wheel practically forms a single pole-piece, and in revolving presents a continuously new point of contact of the same polarity to the rail, the flow of the lines of force being most intense through the lower half of the wheels, and on a perpendicular line connecting the center of the axle with the rail. In winter all that is necessary is to provide the motor-car with a suitable brush for clearing the rails sufficiently to enable the wheels to make good contact therewith, and any tendency to slipping or skidding may be effectually checked. By this means it is easily possible to increase the tractive adhesion of an ordinary railroad motor from 50 to 100 per cent. without any increase in the load or weight upon the track, for it must be remembered that even that portion of the increased friction due to direct attraction does not increase the weight upon the road-bed, as this attraction is mutual between the wheels and the track-rails; and if this car and track were placed upon a scale and the circuit closed, it would not weigh a single ounce more than with the circuit open.

It is obvious that this increase in friction between two moving surfaces can also be applied to check as well as augment the tractive power of a car or train of cars, and I have shown, in connection with this model, a system of braking that is intended to be used in conjunction with the electro-magnetic traction system just described. You will have noticed that in the experiments with the traction circuit the brake-shoes here have remained idle, that is to say, they have not been attracted to the magnetized wheels. This is because a portion of the traction current has been circulating around this coil on the iron brake-beam, inducing in the brake-shoes magnetism of like polarity to that in the wheels to which they apply. They have, therefore, been repelled from the wheel-tires instead of being attracted to them. Suppose now that it is desired to stop the motor-car; instead of applying the traction circuit, the current flowing through the helices is simply reversed by means of the pole-changing switch, whereupon the axles are magnetized in the opposite direction, and the brake-shoes are instantly drawn to the wheels with a very great pressure, as the currents in the helices and the brake-coil now assist each other in setting up a very strong magnetic flow, sufficient to bring the motor-car almost to an instant stop, if desired.

The same tractive force as has previously been applied to increase the track adhesion now exercises its influence upon the brake-shoes and wheels, with the result of not only causing a very powerful pressure between the two surfaces, due to the attractive force, but also offering an extremely large frictional resistance, by virtue of the molecular interlocking action before referred to—part traction and part braking.

The method just described is equally applicable to increase the co-efficient of friction in apparatus for the transmission of power, its chief advantage for this purpose being the ease and facility with which the amount of friction of two wheels can be varied to suit different requirements, or increased or diminished (either automatically or manually), according to the nature of the work being done. With soft iron contact surfaces, the variation in friction is very rapid and sensitive to slight changes in current strength, and this fact may prove of value in connection with its application to regulating and measuring apparatus. In all cases the point to be observed is to maintain a closed magnetic circuit of low resistance through the two or more surfaces, the friction of which it is desired to increase, and the same rule holds good with respect to the electric system, except that in the latter case the best effects are obtained when the area of surface in contact is smallest. For large contact areas the magnetic system is found to be most economical, and this system might possibly be used to advantage to prevent slipping of short wire ropes and belts upon their driving-pulleys (in cases where longer belts are inapplicable), such as in the driving of dynamos and other machinery.

Experiments have also been and are still being made with the object of increasing friction by means of permanent magnetism, and also with a view to *diminishing* the friction of revolving and other moving surfaces, the results of which will probably form the subject matter of a subsequent paper.

Enough has been said to indicate that the development of these two methods of increasing mechanical friction opens up a new and extensive field of operation, and enables electricity to score another important point in the present age of progress. The great range and flexibility of this method peculiarly adapt it to the purposes we have considered, and to numerous others that will, doubtless, suggest themselves to you. Its application to the increase of the tractive adhesion of railroad motors is probably its most prominent and valuable feature at present, and is calculated to act as an important stimulus to the practical introduction of electric railroads in our city streets, inasmuch as the claims heretofore made for cable traction in this respect are now no longer exclusively its own. On trunk-line railroads the use of sand and other objectionable traction-increasing appliances will be entirely dispensed with, and locomotives will be enabled to run at greater speeds with less slipping of the wheels and less danger of derailment. Their tractive power can be nearly doubled without any increase in weight, enabling them to draw heavier trains and surmount steeper grades without imposing additional weight or strain on bridges and other parts of the road-bed. Inertia of heavy trains can be more readily overcome,

loss of time due to slippery tracks obviated, and the momentum of a train at full speed almost instantly checked by one and the same means.

The Future of Electrical Transportation.

(From the *Electrician and Electrical Engineer.*)

THE application of electricity as a motive power for railroad trains, the earliest conception of which appears to be due to that eccentric genius, Henry Pinkus, "late of Pennsylvania, in the United States of America, gentleman," who flourished in London *circa* 1840, has apparently passed through its preliminary experimental period, as exemplified by the work of Siemens at Berlin, Edison at Menlo Park, Finney at Pittsburgh, and Field at Chicago, and has now reached the stage of a somewhat extended practical development. This era in the progress of the art may be said to have commenced with the Lichterfelde line of Siemens, opened May 16, 1881, which was followed by the Portrush line, September 30, 1882, and these two by many others, as given in Mr. Martin's table recently published. At the present moment a glance at the technical journals is sufficient to show that electric railroad enterprises are springing up like mushrooms in every direction, both in this country and abroad.

It may not be uninteresting at the present juncture to attempt to forecast some of the probabilities of the future development of electric transportation, in the light of what has already been accomplished.

In one field, that of surface street railroads, the universal employment of the electric motor is without doubt only a question of time, and not a very long time either. The practical success which has everywhere attended the introduction even of the comparatively crude methods and apparatus at present in use are a sufficient evidence of the ultimate fulfilment of the prophecy. Even the ingenious and efficient, though expensive, cable system is certainly destined to follow the patient plodding horse into the limbo of superseded and obsolete street-car motors.

The next field to be occupied is that of the elevated and other city and suburban rapid transit passenger lines. This undertaking is a far more difficult one, but its accomplishment may, in our opinion, be looked for at no distant day. The conditions of the problem have been thoroughly mastered, the obstacles to be met with are sufficiently well appreciated and understood, and meanwhile several of the ablest practical electricians of the day are devoting their best energies to the subject. No less than 4 electric locomotives designed for this class of service are under construction by different parties at the present time, and we shall be much disappointed if one or more of them does not, upon trial, give sufficiently favorable results to render the future success of electric traction on railways of this class an assured success. The relief to the public in being freed from the annoyance of steam, smoke and cinders, and in great measure of noise as well, will be incalculable, while the probable resulting economy in operating expenses, although in our opinion considerably overestimated by sanguine inventors, will, nevertheless, be sufficient to render the change a profitable one to the owners of the roads.

Another field, and one in which the electro-locomotive of the future may be expected to achieve its greatest triumphs, is that of rapid passenger traffic between our chief commercial centers. Steam locomotion, so far as speed is concerned, has practically reached its limit. The unavoidable restrictions of bulk and weight forbid any material increase in the power of the express locomotive of to-day. No such restrictions apply to the electric engine. The amount of power which by this means it is possible to apply to the axles of an ordinary train without materially increasing its weight, may, without exaggeration, be said to be almost limitless. We believe that the rapid transit railroad of the future will have its trains propelled by electricity; it will be straight, as the crow flies; it will follow the topographical undulations of the country almost regardless of grades, and its trains will attain a speed of more than 100 miles per hour with safety. Without doubt, this may be looked forward to as the next great step in the progressive improvement of the art of transportation.

It remains to speak of another development of electric transport, which for some occult reason has failed, at least in this country, to attract the attention that its importance deserves—the telpher system.

This ingenious invention, although apparently perfectly successful at Glynde, England, where it has been for quite a long time in practical operation, can be expected to have but a limited field of usefulness in the land of its nativity, compared with that which awaits it in the rugged and mountainous regions of our western mining States, to say nothing of the vast undeveloped territories of Mexico and Central and South America.

We have thus briefly indicated some of the probable future lines of development of electric transportation. Doubtless many others will discover themselves from time to time, as the ceaseless march of improvement goes on; but what the ultimate outcome will be is scarcely less difficult of prediction at the present moment than it was in the days of "Henry Pinkus, of Pennsylvania," now almost half a century ago.

Coal Production in Russia.

(Report of A. J. Fay, U. S. Consul at Stettin, to the State Department.)

IN Russia a further rise in the duty on iron is impending, and the owners of the Donetz coal mines have also the prospect that further taxes will be imposed on foreign coal.

The output of Russian coal in 1860 amounted to 10,000,000 poods (about 164,000 tons), whereas it increased in 1885 to 262,000,000 poods (about 4,360,000 tons), of which the Donetz District mined about 2,000,000 tons, the Perm District about 250,000, Poland 1,300,000, Moscow 500,000, and the Killo District the balance.

Notwithstanding this enormous increase, the production of coal in Russia only amounts to 0.3 per cent, of the total output of the seven leading countries of the world.

The production of coal being so small in Russia, one would think that it would be a staple article, and that the mines in the Caucasus, the Ural, Siberia, Turkestan, etc., could be advantageously worked; but such is not the case, as the output of the Donetz Basin of 2,000,000 tons, which consists of nearly 40 per cent. of anthracite, partly remains unsold. In the years 1883 and 1884, nearly 15 per cent. of the output remained unsold; nevertheless several million fathoms of wood are annually burned.

In order to stop the importation of English coal a duty of 2 copecks per pood (about 70 cents per ton) in gold was petitioned for and granted for the ports of the Black Sea, and ½ copeck per pood for the ports of the Baltic; but this had not the desired effect. The English coal could not be displaced, and a higher duty was necessary. Three copecks were granted for the Black Sea ports; but even this duty does not displace the English coal from these ports. Now it is proposed to further raise the duty to 3½ copecks from the Black Sea ports and 2 copecks for the ports of the Baltic. Probably this higher duty will not have the desired effect, because, according to the Riga and Odessa Exchange Committee and the Moscow Technical Society, the Donetz coal is inferior to the English and German; moreover, the cost of producing or mining the coal is greater than is the case in the last-named countries. Russia is still very backward with its technical contrivances in mining.

Mr. Radzig is of the opinion that a further advance in the duty on coal for the ports of the Black Sea would be detrimental to agriculture in the South. Respecting a higher duty for the Baltic ports, the consumption of coal at Moscow would decrease rapidly.

At the present prices of 22 to 23 copecks per pood the consumption of coal at Moscow does not exceed 10,000,000 poods, as many manufacturing industries burn wood, and a higher duty would compel all other industries to use the same fuel, while the Donetz coal owners would certainly not profit by it. Moscow, with the surrounding country, consumes annually about 1,000,000 fathoms of

wood, equal to 100,000,000 poods of coal, and the Donetz District could not only supply the manufacturers, but also the owners of houses as well, if coal could be had at reasonable prices, but high prices would induce none to make a change.

English coal, which is far superior to the Donetz coal, is difficult to place at 22 to 23 copecks, whereas Donetz coal at these prices would find no purchaser if an increased duty should be granted.

In order to augment the sales of the Donetz coal the construction of a railroad is contemplated, which will be about 60 German miles in length, the estimated cost of which is 22 000,000 rubles. Mr. Radzig is of the opinion that this road will have neither freight nor passengers to transport, and that the sale of the Donetz coal can only be augmented by the projected canal which is to connect the Azov with the Black Sea. He writes that this canal will be built by a French corporation, with a capital of 25,000,000 rubles. The Azov is very stormy, and is only navigable about 60 days in the year, this being the reason that the cost of transportation of coal from Marinpol to Odessa or Nicolajau is high, namely, 5 to 8 copecks per pood.

The transporting of coal from Marinpol by canal would probably not exceed 3 to 4 copecks per pood, which would enable the Donetz coal to compete with the English coal.

Mr. Radzig writes that the Donetz coal, because of its bad quality, will never be able to compete with the English article at the Baltic ports, and that only by reducing the railroad freights will it be possible to open up larger markets for it.

Russia has two large manufacturing centers, namely, Poland and Moscow, with surrounding districts. The former has good coal in the vicinity, which is mined mostly by Germans. The latter uses wood, or the dearer and worse Donetz coal. The English coal cannot be obtained, because of the high railroad rates and the increased duty.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 362.*)

WE continue below the condensed summary of the reports of the Board of Trade Inspectors on accidents on British railroads, resulting from breakages of wheels and tires. This summary was begun in the June number of the JOURNAL, and in that number its method and purposes were explained.

In the last number the reports closed with the year 1875; the present summary covers the years 1876–1881, inclusive.

ACCIDENT REPORTS.

February 7, 1876, passenger train on London & Southwestern road was derailed near Micheldever, by the breaking of a tire under a brake-van. Three cars left the rails, and a passenger was hurt. The tire broke into six pieces, five of which were scattered along the line, while the remaining one could not be found. The tire was of Bessemer steel and was put in use in June, 1873; it had been turned down in October, 1874. It was 1½ in. thick on tread at the time of the accident. It was fastened to the wheel on the Beattie system, having a slanting dovetail on the outer side and 8 clips on the inside. In the case of four of the parts of the tire hammered down over the clips, the portions hammered down had been broken away, while a fifth was cracked nearly through. One of the breaks showed an old flaw extending over about one-third of the section. In this case the wheel-center also broke, one-half the rim and three spokes having been broken off. The Inspector, while admitting that this system of fastening was a decided advance on the old method of using rivets, says: "The weakness of this system of fastening, which I have previously had occasion to point out, was conspicuous in this instance of failure. The slanting dovetail at the edge did not possess the security afforded by a squared shoulder; and the hammered-down portions of the lip were not strong enough to resist the strain exerted by the tire, as, in flying open on fracture, it escaped from the slanting surfaces. It is only another proof that, as I have often pointed out, the best principles which can be adopted in tire-fastenings are those of squared shoulders and continuous clips on both sides of the tire."

June 5, 1876, a passenger train on the Great Eastern Railway was derailed near Edmonton Junction by the breaking of a tire under the brake-van. No car left the rails except the van. A guard was hurt. The tire was cast-steel, had been in use three years and had been twice turned off. It was originally 2⅛ in. thick on the tread, and had, by wear and turning, been reduced to 1⅛ in. It was secured to the wheel by a lip on the outside and 5 screw-bolts, ⅞ in. in diameter, screwed from the rim of the wheel to a depth of ¾ in. into the tire. This was an old fastening, the company having since adopted the Mansell fastening for its tires. The Inspector says: "The system of tire-fastening used on this wheel has two principal defects: 1, The absence of a continuous clip on the outside of the wheel. 2, The want of a square shoulder on the clip applied to the inside of the wheel. It is the more necessary to draw attention to these defects, because the locomotive and carriage superintendents of some railroads are still in the habit of adopting a similar system of fastening for the wheels of engines, as well as in some cases for the wheels of vehicles used in passenger trains."

December 17, 1878, a brake-van in a passenger train on the Midland Great Western (Ireland), was derailed near Blanchardstown by a broken tire. This tire was of crucible steel, was two years old and had been worn down from 2 in. to 1¾ in. thick on tread. It was 42 in. diameter and was fastened to the wheel-center by 4 bolts. It broke into four pieces, all of which left the wheel. No cause is assigned for the breakage other than "the brittle state of the metal and hard condition of permanent way induced by the severe frost."

December 20, 1878, locomotive of passenger train on Midland Great Western (Ireland), was derailed near Donamore by the breaking of the tire on a driving-wheel. The tire broke in one place only; it did not leave the wheel but opened out about ⅝ in. at the break. The tire was of crucible steel, had been in use 7 years and had run 115,043 miles. It was 6 ft. 6 in. diameter, and had been worn and turned down from 2½ in. to 1⅞ in. thick on the tread. It was fastened to the wheel-center by bolts or set-screws passing through the rim and into the tire. It broke transversely through a bolt-hole, and no flaw being apparent at the break. A damaged rail was found in the track, and it was most probable, the Inspector thought, that the breakage of the tire was caused by striking this damaged rail. The weight on the single pair of drivers was 14¾ tons.

September 24, 1880, a carriage in a train on the London, Brighton & South Coast road was derailed near Ford Junction by the breaking of a wheel. This was a Mansell wheel with wooden center, and the woodwork broke away entirely from the hub. The Inspector says: "The central portion connecting the tire of the wheel with the boss was entirely of teak-wood, 3½ in. thick, the tire being fastened to the wood by two circular plates or rings of wrought-iron, 3 in. wide by $\frac{7}{16}$ in. thick, one on each side, by 16 bolts ⅝ in. diameter. The central part of the wood is secured to a circular cast-iron plate, 20 in. diameter and 1⅛ in. thick, forming part of the inside of the boss of the wheel, by 8 bolts ⅞ in. diameter, passing through this cast-iron plate, through the ring and through a circular plate or ring of wrought-iron 5½ in. wide and ¾ in. thick on the opposite or outside of the boss of the wheel, the nuts being on the inner side." In this case the wood seemed to be good and sound, but was torn entirely away from the hub. The cast-iron plate was broken into 9 pieces, but the bolts were not broken. It was thought that the holes in the wood had worn and grown loose, and that the final break was due to the torsion produced by application of the brakes.

The Inspectors' general report for the year 1880, says: "Of the 1,238 tires which failed, 50 were engine tires, 50 tender tires, 13 carriage tires, 40 van tires and 1,085 wagon tires. Of these tires 993 were of iron and 231 of steel, while in 14 cases the material was not stated. There were 50 fastened to the wheel by Gibson's method, one of which left the wheel when it broke; 24 by Beattie's method, 16 by Mansell's, 40 by Drummond's and one by Brotherhood's, all of which remained on the wheels when they failed; 1,090 were fastened to the wheel-centers by bolts or rivets, of which 10 left the wheels when broken; 17 were secured by other methods, none of them leaving the wheels. There were 96 tires broken at rivet-holes, 215 in the solid, 13 at the weld and 914 split longitudinally or bulged.

In 1881, again, no wheel or tire accidents were especially reported on. The Inspectors' general report says: "Of the 1,286 tires which failed, 66 were engine tires, 46 tender tires, 8 carriage tires, 55 brake-van tires and 1,111 wagon tires. Of the tires 993 were of iron, 293 of steel; 46 of the tires were fastened to the wheel-centers by Gibson's patent method, 21 by Beattie's patent, 16 by Mansell's patent, 45 by Drummond's patent, all of which remained on their wheels when they failed. There were 1,134 tires fastened to the wheels by bolts or rivets, and 8 of these left their wheels when they failed. In addition, 24 tires were fastened by various other methods and none of these left the wheels on failure. There were 138 tires broken at rivet-holes, 307 in the solid, 7 at the weld and 834 split longitudinally or bulged.

In the year 1876, there were 880 breakages of tires and 74 of wheels reported. In these 954 accidents, only two persons were injured and, as seen above, only two of the accidents were serious enough to require investigation.

In the year 1877, the total number of accidents reported by the railroads of the United Kingdom, as resulting from breakage of tires, was 918; from breakage of wheels, 37; a total of 995 accidents. That these accidents were slight in their nature is shown by the fact that in the whole number not a single person was reported as killed or injured. In fact they were generally of so small importance that none of them required special investigation, and no reports on accidents of this class were made by the Inspectors. Apparently those officers had become tired of repeating their advice on the subject of better fastenings for tires, or else that advice had been taken, with the result of making tire-breakages comparatively harmless, although it had not been possible to prevent them altogether.

In the year 1878, there were reported no less than 1,034 accidents from broken tires and 20 from broken wheels; a total of 1,054 accidents. In all of these accidents there was only one person injured, a railroad employé. As in 1877, while the number of these accidents was large, they were evidently slight in their nature. At any rate only two special reports were thought necessary; both of these accidents were on the same road.

In 1879, there were 1,227 broken tires and 19 broken wheels reported; in all these accidents only 2 employés were injured, and no accidents were specially reported on.

In 1880, there were 1,238 broken tires and 7 broken wheels, and only one accident was reported on, a broken wooden wheel.

In 1881, while 1,286 broken tires and 3 broken wheels were recorded, there were no special reports made by the Inspectors.

From 1875 to 1881, inclusive, the number of breakages of wheels and tires reported by the railroad companies, with the total train mileage for each year, was as follows

	Breakages.			
	Wheels	Tires.	Total.	Train-mileage.
1875	660	112	772	209,528,186
1876	880	74	954	215,711,739
1877	918	37	955	219,895,751
1878	1,034	20	1,054	221,376,114
1879	1,227	19	1,246	225,851,842
1880	1,238	7	1,245	240,956,494
1881	1,286	3	1,289	259,629,442

The comparison with train mileage is necessarily a very unsatisfactory one, when as the varying length of trains of different description is considered. It must also be remembered that during the years covered by the table, there was a gradual increase in the size of locomotives, so that a train-mile in 1881 probably represented a greater mileage of vehicles than in 1875. A much more satisfactory way would be to follow the method in use in German railroads, where reports are made, not by train-miles nor even by car-miles, but by *axle-miles*. This plan of following the axle-mileage would be of comparatively little importance in this country, where all but comparatively a very few cars have light wheels; but in England and other European countries, where cars have four, six or eight wheels, it is necessary to go further than car-mileage, if accurate statistics are wanted.

(*To be continued.*)

Manufactures.

The Lake Champlain Iron Region.

THE Lake Champlain iron and ore interests took a decided advance during the past spring, and the present summer as yet shows no decline in the boom. The two furnaces at Port Henry, N. Y., formerly owned by the Bay State Iron Company, were purchased last November by Witherbees, Sherman & Foote and one of the furnaces put in blast in February after being idle for three years. The other has been undergoing repairs and is now about ready to start.

The Cheever Ore-bed property lately purchased by Tuckerman & Presbury is again being worked, half of the ore used at the Bay State Furnace coming from that mine. The ore is a rich magnetite carrying about 0.30 phosphorus and no sulphur.

The Cedar Point Furnace, blown out in January, has been relined and repaired and is now running smoothly.

The Crown Point furnaces have been shut down for repairs and are now ready to start.

The Chateaugay Mine at Lyon Mountain has worked through the "horse" that had caused much apprehension and is now yielding as usual.

The iron mines at Mineville (Witherbees, Sherman & Co. and Port Henry Iron Ore Company) are showing a good output.

Foot-Guard for Frogs and Switches.

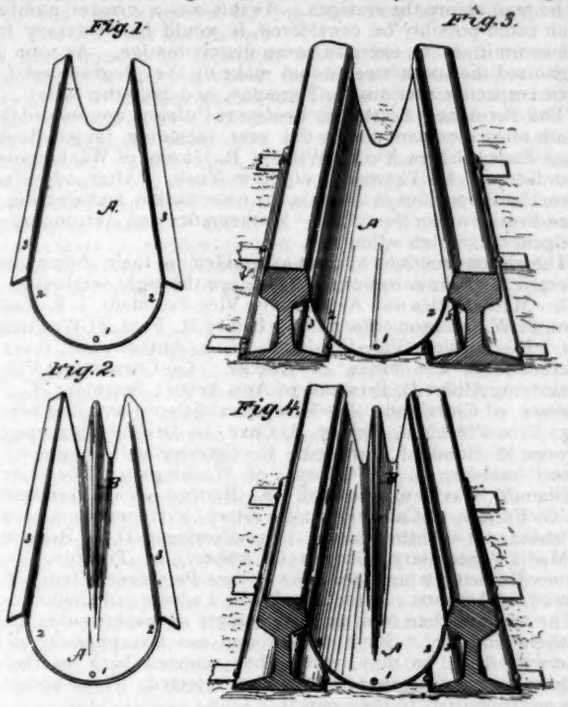
THE accompanying illustrations show a form of foot-guard for frogs and switches recently patented. The object is to fill the space in the frog, switch or guard-rail so as to make it impossible for a person to catch his foot or to trip, and at the same time to leave space for the wheel flanges; there is the further advantage that the accumulation of snow or ice is prevented.

The inventor describes his device as follows: "The foot-guard *A* may be made of sheet-iron, steel or any other metal of sufficient strength, or of paper or other composition, and may be made to fit any angle needed in the frog, switch-rails, guard-rails or other angles, and of a height to fit any rail used in building railroads. It has a bottom portion, 1, side wings 2, and lateral flanges 3, and is put in place by shoving it into the open space between the rails of the frogs, switch-rails, or rail and guard-rail from the wide end of the angle, with the longitudinal flanges so turned as to fit closely under the ball of the rail, the outer edge of the flange extending to the concave of the rail and the inner edge projecting even with the ball of the rail, the sides 2 extending downward and inward at 1 in

nearly a semicircular form, the bottom resting upon the ties and spiked or nailed to one or more of them. Its length must be governed by the angle of the frog, switch-rail or guard-rail. It must extend far enough into the narrow end of the angle to prevent the insertion of a foot in front of it, and far enough back to prevent the sole of the largest boot being caught under the ball of the rail.

"The general shape of the foot-guard, as seen when the flanges 3 on either are under the ball of the rail, is nearly a semicircle with the convex side downward, the angles being sharper at the narrow end and widening toward the other end, according to the angle of the rails.

"In the construction shown in figs. 2 and 4 there is a corrugation, *B*, rising in the center at the narrow end of the guard nearly as high as the sides, giving the end the form of the letter **W**, and this corrugation *B* slopes gradually toward the wider end of the foot-guard, when it entirely ceases or merges



EDWARD'S FOOT-GUARD FOR FROGS AND SWITCHES.

in the base of the guard having a flat rounded surface. This center corrugation should be of such height and the space between it and the sides such that it will not come in contact with the flange on the car-wheel.

"In the construction shown in fig. 3 the foot-guard is nearly semicircular in shape, with the longitudinal sides or flanges bent out at an angle to fit tightly under the ball of the rail.

"The construction shown in figs. 2 and 4 is like that shown in figs. 1 and 3, except that in the narrow end the center is doubled up, so as to form the corrugation, which slopes gradually toward the wider end, where it entirely ceases. This form is particularly intended for use where the rails are close, to prevent the foot from going down between the rails."

The patent, which is No. 367,609, dated August 2, 1887, has been granted to Mr. Edward P. Edwards, of Webster City, Iowa.

Manufacturing Notes.

THE Brownell & Wight Car Company is building a large addition to its shops in St. Louis.

THE contract for the new Belle Isle bridge at Detroit has been awarded by the City Council to the Detroit Bridge & Iron Works for $280,000.

THE Pond Engineering Company in St. Louis is very busy. The company has recently sold a number of the Lowe feed-water heaters and purifiers.

THE Armington & Sims Engine Company has bought the Monobassett Mill property at Providence, R. I. As soon as the plant can be transferred, the company will largely increase its facilities for building its engines.

IT is said that an English concern, the Moss Bay Hematite Steel & Iron Company, purposes establishing extensive steel works at a point near Seattle in Washington Territory, where there are extensive deposits of iron ore.

THE Smith, Beggs & Rankin Machine Company in St. Louis is building two stationary engines with 30 × 60 in. cylinders for the new Olive Street cable railroad in that city. These engines are expected to work up to 1,200 H. P.

THE La France Company in Elmira, N. Y., has just completed a double pumping engine for a new fireboat built for the city of Buffalo, N. Y. These pumps can throw ordinarily 4,000 gallons an hour, and can be worked up to 5,000 gallons an hour if necessary.

THE Atchison, Topeka & Santa Fé Company has ordered two locomotives of the Strong pattern. One, with six drivers, will be built at the Schenectady Locomotive Works, and the other, with four drivers for passenger service, at the Hinkley. Locomotive Works in Boston.

THE St. Louis Car Company, a new concern, is building extensive works in St. Louis for the manufacture of street, cable and elevated railroad cars. The officers are: Daniel McAllister, President; P. M. Kling, Vice-President and Manager; William Lefmann, Secretary and Treasurer.

A SYNDICATE of iron manufacturers of Wheeling, W. Va., organized under the name of the East Chicago Steel Company, has leased for five years the Bessemer-steel plant at Hammond, Ind., just completed by the Chicago Steel Manufacturing Company. A blast furnace and rolling-mill are to be added to the plant.

THE Dickson Manufacturing Company in Scranton, Pa., is building 9 locomotives for the St. Paul & Duluth road and 2 shifting engines for the Brooklyn Bridge. The company recently shipped to Anaconda, Montana, a set of compound hoisting engines having cylinders 26 and 42 in. diameter and 72-in. stroke.

THE Rhode Island Locomotive Works in Providence have just completed a locomotive of the Forney pattern for the New York, Providence & Boston road. It has 15 × 20 in. cylinders and 56-in. drivers; the boiler is 44 in. diameter and the fire-box, for anthracite coal, 66 in. long. The total wheel-base is 22 ft. 7 in. and the weight 90,000 lbs. It is intended for service on the Pawtuxet Valley Branch.

THE Lawrence Machine Company, of Lawrence, Mass., has just been awarded the contract for one of the largest pumping plants ever planned in this country. The plant is for the city of Montreal, P. Q., and consists of four centrifugal pumps, each with a discharge opening of 24 in. diameter and capable of handling 18,000 gallons of water per minute, and four similar pumps of 15 in. discharge opening and a capacity of 7,000 gallons per minute. Thus the four 24-in. pumps have a combined capacity of 72,000 gallons per minute, 4,320,000 gallons per hour, 103,680,000 gallons or 386,000 tons of water per day of 24 hours, and the four 15-in. have a combined capacity of 28,000 gallons per minute or 1,680,000 gallons per hour. These pumps are contracted for by the Inundation Committee of Montreal, and are designed to pump the sewerage of the city over the walls and dykes now in process of erection, to protect the lower portions of the city from the annual inundation caused by the floods and ice gorges of the St. Lawrence River.

Marine Engineering Notes.

THE Union Iron Works in San Francisco recently launched the new steel steamer *Premier*, which is intended to run on Puget Sound for the Canadian Pacific Railway Company.

THE Quintard Iron Works in New York City have the contract for a triple-expansion engine for the new steamer *Chemung*, now building at Buffalo for the Union Line between that port and Chicago.

A NEW ferry-boat is nearly completed at San Francisco, for the South Pacific Coast Railroad; she is to run between San Francisco and Alameda, and will have a capacity of 2,500 passengers. The boat is 265 ft. long, 75 ft. beam over all, and 16 ft. depth of hold. The engines are built by the Fulton Iron Works.

THE Baltimore & Ohio Railroad is to have a new steam ferry-boat for transferring trains between Locust Point and Canton in Baltimore Harbor. This boat, which is named *John W. Garrett*, was launched from the Harlan & Hollings-

worth Company's yard in Wilmington, Del., August 2. The boat is 366 ft. long and 76 ft. wide over all, and will carry 15 passenger or 30 freight cars at a trip.

It is stated that the Cleveland Shipbuilding Company in Cleveland, O., has taken a contract to build two steel steamers for the Lackawanna Transportation Company. The new vessels are to be 275 ft. long, 38 ft. beam and 25 ft. hold, and are to run between Buffalo and Chicago.

The Cleveland Forge Company, of Cleveland, O., have received the contract to furnish the new steamer *Puritan*, of the Fall River Line, and the steamer building for the Providence Line with all their heavy forgings, such as shafts, cranks, pins, etc. The *Puritan's* main shaft will be 28 in. in diameter and weigh 42 tons, the largest shaft ever forged in America. Her beam strap will weigh about 19 tons, this being the largest one ever made. The Providence steamer's shafts will be 25 in. in diameter. The Cleveland Forge Company furnished the lake steamer *Owego* and her consort now building with shafts, cranks and pins. These steamers' cranks weigh 22 tons each.

The Old Colony Steamboat Company has let contracts for its new steamboat *Puritan*, which is to run on the Fall River Line between Fall River and New York. The *Puritan* will be larger than the *Pilgrim* of the same line, and will, it is claimed, be the largest steamboat for inland waters in the world. She will cost about $1,500,000 and will be finished early in 1889. Her length is to be 404 ft. at the water-line and 420 ft. over all, which is 30 ft. longer than the *Pilgrim*. The beam will be 52 ft. and 90 ft. across the guards, with a depth of hold of 21 ft. 4 in. She will have 355 state-rooms. The hull is to be constructed on the double-hull bracket-plate and longitudinal system, with the bottom divided into 50 water-tight compartments. In addition to these compartments, six water-tight bulkheads will extend to the main deck. The hull is to be built at John Roach & Sons' yard at Chester, Pa.; the upper-works, cabins, etc., by William Rowland, of New York.

The *Puritan* will have a compound-beam engine, having a high-pressure cylinder 75 in. diameter and 9 ft. stroke and low-pressure cylinder 110 in. diameter and 14 ft. stroke. The paddle-wheels will be feathering wheels, of the same pattern as those used in the *New York* of the Albany Day Line on the Hudson River. She will have 8 steel boilers, intended to carry a working pressure of 110 lbs. The engines will be built by the W. & A. Fletcher Company at the North River Iron Works in New York City.

Messrs. Robert Palmer & Sons at Noank, Conn., are building a new wooden steamboat for the Providence & Stonington Steamship Company, to run on the line between Providence and New York. The steamboat will have a frame of white oak, live oak and hackmatack and planking of white and yellow pine. The hull will have six water-tight bulkheads of 2-in. white pine. The length on water-line will be 345 ft.; over all. 357 ft. The breadth of beam will be 47 ft. 6 in.; breadth over guards, 85 ft. The depth will be 17 ft. 3 in.

The engines will differ from those of nearly all the boats running on Long Island Sound, which are of the beam pattern. They will be compound oscillating engines with high-pressure cylinder 56 in. and low pressure 104 in. diameter; both 11 ft. stroke. Both cylinders will have the Wheelock gridiron valve, and the valve-motion will be of the link type. The cylinders will be set at an angle of 100° with each other. Steam will be supplied by six boilers, 12 ft. 6 in. diameter and 20 ft. 3 in. long, each having three corrugated furnaces 4 ft. diameter and 7 ft. 6 in. long; the working pressure will be 130 lbs. The engines will have surface condensers. The paddle-wheels will be of the feathering type, 29 ft. diameter, with 12 buckets, each 14 ft. face and 4 ft. 6 in. wide. The engines are expected ot develop 4,500 I. H. P.; they have been designed by Mr. George B. Mallory, the company's Engineer.

The Strong Locomotive.

The Strong Locomotive Company is now building three locomotives of the Strong pattern for the Atchison, Topeka & Santa Fé Railroad. They are to be used on the fast express trains on the new extension to Chicago. One of these engines will have 19 × 26 in. cylinders and three pairs of drivers; the other two will have 18 × 24 in. cylinders and four 68-in. drivers.

A locomotive for the Michigan Central is also under way; it will have 18 × 24 in. cylinders and is to run on fast express trains between Chicago and Detroit. The company has several other orders on hand.

Proceedings of Societies.

American Association for the Advancement of Science.

The 36th meeting of the American Association for the Advancement of Science convened at Columbia College, New York, on Wednesday, August 10, about 1,000 persons being present. The President of the Association, Professor S. P. Langley, presented the President of the College, Dr. Barnard, who made a speech of welcome in the name of the Trustees of Columbia College.

The General Secretary, Professor Pettee, announced the addition to the Association of over 200 members since the meeting at Buffalo last year. Some 300 papers had been submitted to be read before the sections. As this was a greater number than could possibly be considered, it would be necessary for the committees to exercise some discrimination. As soon as organized the committees would make up the programmes for their respective sections for Thursday, and daily thereafter.

The Permanent Secretary, Professor Putnam, announced the death of 25 members during the year, including James Buchanan Eads, of New York; William B. Hazen, of Washington, and Edward L. Youmans, of New York. After adopting several unimportant changes in the constitution and electing a Vice-President for Section A—Mathematics and Astronomy—the general session adjourned.

The various sections at once assembled in their rooms and effected their organizations. These are the eight sections:

A—Mathematics and Astronomy: Vice-President, J. R. Eastman, of Washington; Secretary, Henry M. Paul, of Washington. B—Physics: Vice-President, W. A. Anthony, of Ithaca; Secretary, C. Leo Mees, of Athens. C—Chemistry, Vice-President, Albert B. Prescott, of Ann Arbor; Secretary, C. F. Mabery, of Cleveland. D—Mechanical Science and Engineering: Vice-President, Eckley B. Coxe, of Drifton: Secretary, George M. Bond, of Hartford. E—Geology and Geography: Vice-President, G. K. Gilbert, of Washington; Secretary, William M. Davis, of Harvard. F—Biology: Vice-President, W. G. Farlow, of Cambridge; Secretary, J. Henry Comstock, of Ithaca. H—Anthropology: Vice-President, D. G. Brinton, of Media; Secretary, Charles C. Abbott, of Trenton. I—Economic Science and Statistics: Vice-President, Henry E. Alvord, of Amherst; Secretary, W. R. Lazenby, of Columbus.

The sections then took up the abstracts of papers submitted to their judgment. Some were found too metaphysical and others too long, so they were either referred back to their authors for condensation or altogether rejected. Those accepted were submitted to the Council.

In the hall of Section B, devoted to physics, Professor W. A. Anthony, of Ithaca, spoke on "The Importance to the Advancement of Physical Science of the Teaching of Physics in the Public Schools." The principles of science should be spread broadcast. Not only boys but girls should receive such training, and young children could appreciate it. A properly conducted scientific education in the primary schools would teach children to avoid the mistake of attempting the impossible and be of great benefit to science. Grammar should be one of the last subjects for a boy to take up. Language should be taught by reading, not by rules. Geography should be taught to give familiarity with the form of the earth Beyond this the geography should be a book of reference. As soon require a child to learn the dictionary by heart as to learn the names of capes, rivers and islands as they are now taught. With regard to arithmetic, interest, discount and partial payments should be cut out of the course and given as part of a business training. Children in their earliest experiences have to do with heat, light, sound, movement and magnetism. Physics should be taught by calling attention to familiar facts and then explaining them.

"Engineering" was the subject of the paper read before Section D, devoted to mechanical science and engineering, by Mr. Eckley B. Coxe, of Drifton, Pa. Engineering, though the youngest of the professions, was already divided into civil, mining, mechanical and other branches. Another subdivision was taking place. To some engineers it was a science, to some a profession, to some a business. The business engineers, that is, men who would engage to build a bridge or do any other engineering work, furnishing plans and guaranteeing to accomplish certain results for a given sum of money, taking all risks, were a very important class. There is no agreement as to what advice should be given to the young men wanting a technical education. In medicine and law the course is prescribed, but when we come to engineering no unanimity is to be found. The great difficulty is that the field attempted

to be covered by engineering is too vast to come under one system.

With these and other equally interesting papers and resulting discussion thereon, the day was passed until evening, when the retiring President, Professor Edward S. Morse, gave an address on "Evolution," which was much appreciated.

SECOND DAY.

On the second day, August 11, the various section rooms were well attended, and though there was little discussion on the papers, that can be accounted for by the fact that, there was such a plethora of matter, little time for outside talk was left.

"A Method of Telephonic Communication Between Ships at Sea," was the title of a paper read by Dr. L. E. Blake before the section devoted to physics. He said that he thought the experiments and the whole scheme antedated all other methods which had been proposed for fog signaling by telephone at sea. The plan was as follows :

A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or at night signals intelligible by means of a code would be produced by it, which would be transmitted in all directions through the water with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus, which would take up out of the water the signals arriving from neighboring vessels. "All of us," said Dr, Blake, "remember when as boys in swimming how distinctly the sound of the striking of stones together under water was heard. Just so distinctly is it possible to send musical tones from one ship to another."

For steamships the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water and to be heard at least six or eight miles. From the nature of its tone it would be easily distinguishable from other sounds, always more or less present under water, from breakers and waves. With such whistles, a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell-buoys were to have a second bell added under water, while lightships, lighthouses and any headlands, might also be provided with submerged bells which could be rung from the shore when necessary ; sailing craft, both large and small, would have bells, and since an ordinary locomotive bell could be heard at least two miles under water, such simple means would seem to afford sufficient limits for protection for such vessels.

"It is believed," said Dr. Blake, "that sufficient has been done to show that the complete solution of this interesting and valuable practical scheme will lie probably in the telephonic method described. By this method, in October, 1885, signals were transmitted and received 1½ miles on the Wabash River from a locomotive bell, around three or four windings of the river, so that the operators were out of each other's sight. The sound could not be heard through the air, yet with fair distinctness could be heard through the telephone."

"Color Blindness Among Railroad Employés" was the title of a paper read before the same section by Dr. William Thompson. Professor of Ophthalmology in the Jefferson Medical College of Philadelphia. He said that the conflict between the officers and the employés of the Reading Railroad, which has occupied the attention of the public and has threatened to produce a suspension of work on that road, had reopened the question of color blindness. In the recent demonstration Dr. Thompson was able to show that an engineman declared a red danger signal at a distance of two feet to be a green light and failed to classify the white, red, green and blue flags properly. In July last 25,158 employés were examined on the Pennsylvania lines east of Pittsburgh and Erie. Of these 481 were color blind, 661 with defective vision and 158 with defective hearing. The officers of the Pennsylvania Railroad and other railroads had adopted Dr. Thompson's system of examination.

Dr. Albert N. Leeds read two papers, the second on "The American System of Water Purification." He said that manufacturing towns increased in population with such rapidity that they soon found their local sources of water supply insufficient in quantity and dangerous to health from pollution by sewage and factory waste. The American system of water purification comprised three distinct features : Artificial aeration under pressure ; precipitation of dirt, sewage, hardening constituents and coloring matters by harmless precipitants ; mechanical filtration through filters capable of rapid reversal of current, and cleansing by mechanical means.

The section on Economic Science and Statistics listened to two important papers read by Professor W. O. Atwater in relation to the food question.

Professor D. S. Martin, of Columbia College, spoke on "The Geology of New York and its Environs" before the section on Geology and Geography. He pointed out the various geological formations which, like great waves, crop out all along the sea coast from the Alleghanies to the sea coast coming down to New York City. Geologists were not agreed upon the age of the rock which forms the backbone of Manhattan Island. He believed it to be archaic, or of the first order. Over Manhattan Island, 1,500 ft. higher than the Atlantic Highlands, an ice wave had swept from the north thousands of years ago and left the sandy deposit now on this and Long Island and Staten Island and portions of New Jersey. Before the period, the ice drift a river ran from the Housatonic Valley in Connecticut through the depression where the East River now is joined and the Hudson below New York Bay. Then together the streams flowed through flat lowlands to the sea, then 60 miles further out than now. The Palisades were then 700 ft. high.

The ladies of the Reception Committee tendered the members an informal reception in the Metropolitan Opera House in the evening, where many not previously acquainted became so. This reception was very largely attended.

THIRD DAY.

On the third day, August 12, the section on geology and geography gave up the whole of the day to a discussion of the report of the American Committee of the International Congress of Geologists. This was a task of greater or less limitations, as the section chose to make it, and they found time to pretty thoroughly go over the work of the International Congress at its Berlin session last year, criticising some parts of it with severity and giving some of it their hearty commendation. Many suggestions were advanced as to what should be done at the next session, which will occur in London.

Section I, on Economic Science and Statistics, gave up the day to statistical questions, three papers being read. The first, "The Testimony of Statistics as to our National Progress," was by Professor E. J. James, of the University of Pennsylvania ; the second, "The Wealth of the Republic," was by Dr. C. S. Hill, and the third, "On the Rates of Interest Realized to Investors in the Bonded Securities of the United States Government," was by Professor E. B. Elliott. Being of an economic character, they aroused a considerable interest, and were well attended by both scientists and laymen. In his paper Professor James, after referring to Professor Atkins' papers read the preceding day, said : "In an examination of the long series of wage receivers whose wages are quoted in the New Jersey statement I fail to find more than a comparatively small per cent., counting in the whole number of laborers, who actually attained the figure of $600 in their income. Six hundred dollars per year means $2 a day for the days of the working year. There must be no days of sickness or leave of absence or vacation or strike, if the sum is to be accumulated by working at $2 a day. Now, $2 per day is very much more than the average unskilled laborer can earn, and if skilled mechanics often earn much more we must remember that their working season is often very short. The amount of comfort or elegance which can be obtained from $2 per day, if one has to support five persons out of it, you can easily reckon out for yourselves. The average earnings of all the laborers reported in the Pennsylvania statistics was less than $400 per annum. The average weekly wage in the coal trade was only $6.20, or $325 per annum. The average weekly wage in foundries employing 17,000 men was less than $9 ; in the Bessemer steel works less than $8.50 ; in hosiery and knit goods less than $5.

"We believe that this is a grave social problem which will require the most careful investigation and cautious action, if it is to be solved without seriously disturbing our social order. The conditions of life are becoming more severe as the years roll on. The prizes open to the successful one are growing larger, but the number of blanks is also rapidly increasing."

In the section on Physics, Professor Elias S. Ries read a paper on The Electric Current as a Means of Increasing and Varying the Tractive Adhesion of Railroad Motors and other Rolling Contacts.

In the afternoon most of the members joined in an excursion around the harbor. In the evening many attended a reception given by the Torrey Botanical Club.

On Saturday, August 13, there was no meeting, the members generally joining in one of the two excursions provided

for their entertainment. One of these was up the Hudson River to West Point, the other down the Bay to Long Branch.

FOURTH DAY.

The arrangements for the fourth day, Monday, August 15, provided for the amalgamation of the mechanical science and engineering section with that devoted to economic science and statistics for the reading and discussion of papers relating to Isthmus Transit. This session was largely attended, and seemed to attract a great deal of attention. It was opened by Commander H. C. Taylor, U. S. N. who read a paper entitled The General Question of Isthmian Transit. This paper was in part a historical account of the various plans for isthmus transit, and in part a comparison of the merits of the Panama Canal, the Tehuantepec Ship Railroad and the Nicaragua Canal—decided preference being given to the Nicaragua plan.

Climatic and Sanitary Notes on the Nicaragua Canal Route was the next paper, read by Surgeon John F. Bransford, U. S. N. He said that the line of mountains forming the continental "divide" in Central America passes through Nicaragua in a northwesterly direction. This brought it across the course of the northeast trades, and the wind rushed over the hills and through the gaps to the Pacific. This breeze, ventilating and drying the country and lowering the temperature, was the great sanitary agent in Nicaragua. By the time the wind reached the lake basins its surplus moisture was gone. The southeast wind predominated during the rainy season. The temperature of Nicaragua was equable. The extreme variation on the line of the canal recorded by Childs was of 23°, his maximum being 91°. The rainfall, based on the records of nine years, showed an average of 64.42 inches. The country, generally, he considered healthy, and residents there needed only to take the ordinary precautions required in all tropical climates. The supply of fresh provisions, beef and fruit, is abundant, and the drinking water is good from one end of the line to the other.

Civil Engineer R. E. Peavy read a paper called "The Engineering Features of the Nicaragua Canal. He said that the distance from ocean to ocean by the proposed route was 169.8 miles. Of this distance, however, only 40.3 miles were actual canal, the other 129.5 miles being free navigation through Lake Nicaragua, the Rio San Juan and the valley of the San Francisco. The lake and river must form a part of every canal route through Nicaragua and the location as a whole was the result of Civil Engineer Menocal's complete and exhaustive personal knowledge of the entire country from ocean to ocean. Of the 40.3 miles of actual canal, about 27 miles would be excavation pure and simple, while the remaining 13 miles would be largely if not entirely excavated by dredges.

"There are two features of this project which to many who have not made such structures a study cause a question of safety to arise. One is the dam, which at one stroke gives us 64 miles of river navigation, and the other is the embankment, which at a second stroke gives us over 8 miles of lake navigation and completely solves, for that portion of the canal from the dam to the divide (13 miles), the important problem of protection from surface drainage. But they are small when compared with many others scattered about the world, and serving much less important purposes than the ones under consideration. Beside the Quaker Bridge dam they are pigmies.

"The necessary machinery for moving the locks and culvert gates, for hauling the ships in and out of the locks, for electric light and other purposes, will be worked by hydraulic power furnished by the locks themselves. Locks are absolute sources of safety. Much has been said about the harbors at the termini of the Nicaragua route. It may be remarked that there is no practical route for a canal across the American isthmus that has good harbors, and it is believed that those at the termini of the Nicaragua Canal can be made first-class at less cost than those of any other route."

This is the estimated time of transit through the canal by steamer, as given by Mr. Peavy: 38.98 miles at 5 miles an hour, 7 hours 48 minutes; 8.51 miles on the San Francisco basin at 7 miles an hour, 1 hour 48 minutes; 64.54 miles on the San Juan River at 8 miles an hour, 8 hours 4 minutes; 56 50 miles on the lake at 10 miles an hour 5 hours 39 minutes; time allowed for passing 7 locks at 45 minutes each, 5 hours 15 minutes; detention in narrow cuts, 2 hours; total, 30 hours.

J. W. Miller, General Manager of the Providence & Stonington Steamship Company, read a paper called Historical and Geographical Notes Concerning the Nicaragua Canal Route.

At the general evening session a formal welcome to the Association was given by the New York Academy of Sciences.

Professor Henry Drummond, of Glasgow University, Scotland, lectured on The Heart of Africa.

Professor Thomas A. Edison, being busy at Menlo Park, was unable to attend the meeting, and therefore intrusted to Professor Baker, of the University of Pennsylvania, who read it before the Physics Section, a paper describing a machine for producing electricity direct from fuel. To do this, says the paper, has long occupied the close attention of inventors. Could the enormous energy latent in coal be made to appear as electric energy, with reasonable economy, the mechanical methods of the entire world would be revolutionized and another grand step of progress would be taken.

Quite recently Lord Rayleigh concluded that from a copper-iron couple a conversion of not more than of the coal energy could be hoped. As a heat engine, therefore, the thermo cell can have no higher efficiency than Carnot's reversible engine. Another line of investigation suggested itself to Mr. Edison. It has long been known that the magnetism of metals is markedly affected by heat. Nickel loses its power of being magnetized at 400°, iron at a cherry red heat, and cobalt at a white heat. Whenever a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor; so it occurred to him that by placing an iron core in a magnetic circuit and by varying the magnetizability of that cone by varying its temperature, it would be possible to generate a current in a coil of wire surrounding the core. This idea constituted the essential feature of the new generator, which therefore he calls a "pyro-magnetic generator of electricity."

The principle was first applied to the construction of a simple form of electric engine, a "pyro-magnetic motor." This consisted of a permanent magnet, having a bundle of small tubes made of thin iron placed between its poles, and capable of rotation about an axis perpendicular to the plane of the magnet. By suitable means hot air passes through these tubes, so as to raise them to redness. By a flat screen placed across this bundle of tubes and covering half of them, access of the heated air to those tubes is prevented. When this screen is so adjusted that its ends are equidistant from the two legs of the magnet, the bundle of tubes will not rotate, since the cooler and magnetic portions beneath the screen will be equidistant from the poles. If the screen be turned about the axis of rotation, so that one of its ends is nearer one of the poles and the other nearer the other, then rotation of the bundle will ensue. The first motor constructed on this principle was heated by means of two small Bunsen burners, and it developed about 700 foot-pounds a minute. A second and larger motor is now about finished, which will weigh about 1,500 lbs., and is expected to develop about three H. P. In both these machines electro-magnets are used in place of permanent magnets, the current to energize them being derived from an external source. In the larger machine the air for combustion is first forced through the tubes to cool them, and then is forced into the furnace at a high temperature.

The construction of a machine of sufficient size to demonstrate the feasibility of producing continuous currents on a large scale was at once begun and has just been completed. The new machine consists of eight elements, each the equivalent of the device already described, arranged radially about a common center. The machine is placed on top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through the armature in turn. The potential difference developed by this dynamo depends upon the number of of turns of wire on the armature coils, the temperature difference in working, the rate of temperature variation, and the proximity of the maximum point of effect. The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyro-magnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and since there is no attendance required to keep it running, it would seem to have already a large field of usefulness for it. By using the regenerative principle in connection with it great improvement may be made in its capacity, and its practical utility may equal the interesting scientific principles which it embodies.

The paper received close attention and was much discussed, a pronounced interest in the outcome of the pending experiments being manifested.

FIFTH DAY.

On the fifth day, August 16, the Association met in general session and passed upon the reports of several committees and the recommendations of the Council. These latter embraced the election of these officers:

President—Professor J. W. Powell, of Washington, Director of the United States Geological Survey.

Vice-Presidents, (Chairmen of Sections)—Mathematics and Astronomy, Ormond Stone, of the University of Virginia; Physics, A. A. Michaelson, of Cleveland; Chemistry, C. E. Monroe, of Newport; Mechanical Science, Calvin M. Woodward, of St. Louis; Geology and Geography, Georgé H. Cook, of New Brunswick; Biology, C. V. Riley, of Washington; Antropology, C. C. Abbott, of Trenton; Economic Science and Statistics, C. W. Smiley, of Washington.

Permanent Secretary—F. W. Putnam, of Cambridge, Mass.

General Secretary—J. C. Arthur, of Lafayette.

Secretary of the Council—C. Leo Mees, of Athens.

Treasurer—William Lilly, of Mauch Chunk.

Auditors—Henry Wheatland, of Salem; Thomas Meehan, of Germantown.

Cleveland was selected as the place of the next meeting, and the fourth Wednesday in August as the date. Several resolutions were adopted. In one of them President Cleveland was asked to at once appoint a permanent Superintendent of the Coast and Geodetic Survey. In response to another a committee to memorialize Congress on the preservation of archaeologic monuments on the public lands was appointed, and the President of the Association was asked to appoint a committee to devise methods for securing a reduction of the duties on scientific books and apparatus. Congress was asked to establish a bureau of standards by which the accurate standards of measure shall be constructed for electricity, heat, light, etc., and arrangements made for the issue of authentic copies. In response to a letter from Professor Cleveland Abbe, meteorologist of the Smithsonian Institution, Congress was asked to publish the "Index to the Literature of Meteorology," prepared by the Chief Signal Officer.

The members then separated to the various sections, where a large number of papers were read.

Before the Economic Section Professor E. J. James, of the University of Pennsylvania, gave his views on Manual Training in the Public Schools from an Economic Standpoint. He thought the question of manual and industrial training the most important educational topic now before the country. "The general introduction into our public schools," said he, "of systematic training in the underlying principles of the handicrafts is the next great step in the development of our educational system—a step for which we are now ready, and which should be taken immediately." The paper was an elaboration of this idea.

Yan Phou Lee, of New Haven, Conn., spoke on The Chinese Question from a Chinese Standpoint.

Professor George F. Kunz detailed some recent explorations made with a view to answering the question: Is there a Diamond Field in Kentucky?

J. R. Haskell discussed the National Armament before the Chemistry Section. The gun of the future, he said, would be multicharge, using slow powder in the breech and quick powder in the chambers.

The Biologic Section adopted a resolution approving the proposition to erect in New York City a monument over the remains of Audubon the ornithologist.

In the evening a reception was given by the Local Committee, preceded by closing exercises in which the thanks of the visitors to the Local Committee and to Columbia College were heartily expressed in several very earnest speeches. The friends of Mrs. Erminie A. Smith, of Jersey City, N. J., who was during her life the only woman ever elected to a position in the Association, gave an opportunity to any who wished, to contribute to the Smith Memorial Fund, for the purpose of putting a window in a church in that city in honor of her memory.

The members of the Association now number 721, about 20 having joined during the session as life members.

The fifth day completed the business of the session, but it did not fulfill the pleasure plans of the scientists. Several excursions were arranged, one party visiting Blackwell's Island, another made a geological exploration of Bergen Ridge and the Palisades. A third accepted an invitation from Lieut. E. L. Zalinski to go to Fort Lafayette and witness the firing of the dynamite gun. Other excursions took place to Saratoga and Lake George, Lake Champlain, and the Adirondacks.

Over 250 papers were presented at this meeting, many of them of great value. We only regret that the unavoidable limits of space prevent us from giving a much fuller summary than has been presented above; and also from presenting abstracts of a number of the papers which were read.

American Institute of Mining Engineers.

THE 48th meeting of this Institute consisted of an excursion in which quite as large a number of members joined as could be expected for so long a trip. The members left Chicago July 1 and went to Denver, Pueblo, Salt Lake, Butte City, Helena and the Yellowstone Park, reaching Duluth on their return July 24. Stops were made at Salt Lake, Butte City and Helena, and the members were hospitably entertained at each of those places. At Butte City, the Anaconda Mine and the great smelting works near by were visited. At Duluth, a number of members, who came to join in the meeting there, were found.

THE DULUTH MEETING.

The Duluth (49th) meeting began on Monday, July 25, when the opening session was held in the new Opera House. Addresses of welcome were made by Mayor J. B. Sutphin and Mr. William F. Phelps, Secretary of the Chamber of Commerce, and suitable acknowledgments were offered in reply by Mr. John Birkinbine, Vice-President of the Institute and acting President for this meeting, and by the Secretary; after which Mr. Birkinbine presented a paper on the Progress of the Lake Superior Region. This was a very long and exhaustive presentation of the present condition and capacities of the region.

In the afternoon an excursion to the Dalles of the St. Louis River was successfully carried out.

At the evening session, held in the parlor of the Duluth Boat Club House, Mr. Birkinbine gave the conclusion of his elaborate paper on the industries of the region. The remainder of the evening was occupied with a most interesting paper by Mr. Per Larsson, of Iron Mountain, Mich., on the Chapin Mine in the Menominee Range. This paper derived special importance from the circumstance that the Chapin, one of the great producing iron mines of that range, was near being ruined by caves, resulting from the attempt to employ the Nevada system of square timbering to hold open the immense stopes, and has been rescued by the introduction of a system of solid filling. The session was concluded with the reading of a Note on the Region North of Vermilion Lake District, by Theodore B. Comstock, Champaign, Ill.

Tuesday was occupied with an excursion to Two Harbors and the Vermilion mines of the Minnesota Iron Company.

The third session was held in the rooms of the Board of Trade on Wednesday morning, July 27, when the following papers were read and discussed:

The Iron and Steel Industry in Canada; J. H. Bartlett, Montreal, Canada.

Two Conditions of Phosphorus in Iron; Prof. B. W. Cheever, Ann Arbor, Mich.

Experiments Illustrating the Descent of the Charge in an Iron Blast Furnace; Prof. R. H. Richards and R. W. Lodge, Boston.

The following papers were read by title:

A Deposit of Bauxite; Edward Nichols, Hermitage, Ga.

Mode of Deposition of the Iron Ore of the Menominee Range; John Fulton, Cambria, Pa.

Method of Mining in the Menominee Range; John Fulton, Cambria, Pa.

Topographical Models and their Construction; J. H. and E. B. Harden, Phœnixville, Pa.

The Incline Railway at Lookout Mountain; W. H. Adams, New York City.

The Lead, Zinc and Copper Reduction Works of the United States; C. Kirchhoff, Jr., New York City.

Wire Rope Haulage; F. C. Roberts, Philadelphia, Pa.

Silicon Determinations in Blast-Furnace Cinder; Clemens Jones, Hokendauqua, Pa.

Coal Mining in Utah; C. A. Ashburner, Pittsburgh, Pa.

Further Notes on the Silver Plant; Ellen H. Richards, Boston, Mass.

The Segregation of Copper-Silver Alloys; F. F. Clausen, New Orleans, La.

Inorganic Standards for the Calorimetric Carbon Test; Theodore W. Robinson, Joliet, Ill.

A Crystalline Sub-Sulphide of Iron and Nickel; J. B. Mackintosh, Bethlehem, Pa.

Carbonate Iron Ores at Enterprise, Miss.; Alfred T. Brainerd, Birmingham, Ala.

The Gogebic Mines; R. A. Parker, Hurley, Wis.

The Vermilion Lake Mines; T. H. Hulbert, Duluth, Minn.

Twenty Years' Progress in the Concentration of Sulphuric Acid; W. H. Adams, New York City.

Some 30 new members and associates were elected at this session, and after the passage of the usual resolution of thanks the meeting was adjourned.

A sail around the harbor of Duluth in the afternoon, and a reception in the evening in the Hall of the Board of Trade, concluded the exercises at Duluth.

On Thursday morning, July 28, the members left Duluth and took a train over the Northern Pacific to Ashland, Wis. On the way a short stop was made at the point where the Ashland Furnace Company is putting up a new charcoal furnace, 60 ft. high with 12-ft. bosh.

After reaching Ashland the party saw the great ore docks, took a sail around the harbor and were entertained by the citizens of Ashland in the evening.

On the following day, July 29, the members took a special train to Hurley, Wis., and from that point as a center proceeded to examine the mines of the new Gogebic iron region. With this excursion and examination the meeting closed, and the members dispersed.

Master Car & Locomotive Painters' Association.

THE 18th annual convention of this Association will be held at the Grand Central Hotel in New York, beginning on Wednesday, September 14, at 10 A. M.

Members desiring to attend and secure rooms at the hotel should apply to the Chairman of the Committee, Alexander Campbell, Manhattan Railroad, New York.

The following list of subjects will be brought before the convention, being introduced by the committees to whom they have been assigned. It is hoped that each member of a committee will be prepared to report fully on the subject, and if unable to be in attendance at the meeting, forward their report to the Secretary, Mr. Robert McKeon, Kent, Ohio, by September 8:

No. 1. It is generally admitted that scarcely two Samples of Japan of Different Manufacture will give like results as to Drying and Binding Qualities. Why should there be such a Variation, and can we not have a Standard of Specifications as to Drying and Binding? In what way shall such a Standard for Japan be determined? Byron Stanbury, Union Pacific, Omaha, Neb.; Alex. Campbell, Manhattan Elevated, New York.

No. 2. Does the addition of Japan to Raw Linseed Oil Retard in Drying if used in Excessive Quantities, and what Variation is there in the Drying Qualities of Japans, when mixed with Raw Linseed Oil? M. W. Stines, Barney & Smith Manufacturing Co., Dayton, O.; A. E. Barker, Chicago & Northwestern, Chicago; R. W. Scott, Delaware Car Works, Wilmington, Del.

No. 3. What is the Maximum Amount of Japan that can be used with Safety, and the Proportion to Raw Linseed Oil? Jos. J. Murphy, Louisville & Nashville, Louisville, Ky.; H. Libby, Charles River, Boston, Mass.; Wm. E. Hibbard, Boston & Albany, Mass.

No. 4. What Quantity of Oil Paint composed of Metallic Paint, Linseed Oil and Japan, should constitute a Good Coat to the Square Yard of Surface, Amount in Weight and also Measure? F. S. Ball, Pennsylvania Railroad, Altoona, Pa.; M. L. Sims, East Tennessee, Virginia & Georgia, Atlanta, Ga.

No. 5. Would it be more Economical for the Painter to Manufacture his own Japan, or continue to use that of the Manufacturer? Geo. O. Widner, late of Lake Shore & Michigan Southern, Buffalo, N. Y.; H. M. Billings, Pittsburgh, Cincinnati & St. Louis, Columbus, O.

No. 6. Management of the Railway Paint Shop. E. L. Bigelow, Baltimore & Ohio, Baltimore, Md.

No. 7. What Constitutes the best Priming Coat of Paint for Locomotives and Tanks? Jno. S. Atwater, Hinkley Locomotive Works, Boston, Mass; F. M. Widner, New York, Lake Erie & Western, Buffalo, N. Y.; C. C. Wood, Pennsylvania & New York, Sayre, Pa.

No. 8. What is the Best Method of Mixing and Grinding Car-Body Colors to Ensure the Greatest Durability? Jacob Hoesly, Pennsylvania Railroad, Meadows Shops, N. J.; Robert McKeon, New York, Pennsylvania & Ohio, Kent, Ohio; John Rattenbury, Chicago, Rock Island & Pacific, Chicago, Ill.

No. 9. Causes of Iron Rusting under the Priming Coat of Paint and the Effect Rust has on Paint? A. J. Bishop, Cleveland, Columbus, Cincinnati & Indianapolis, Delaware, O.; C. C. Young, Chicago, Rock Island & Pacific, Trenton, Mo.

No. 10. Is it Advisable to Paint the Inside (water space) of an Engine Tank to protect it, and what Material would you consider it best to use? Samuel Brown, Old Colony, Boston, Mass.; E. E. Earl, Northern Pacific, St. Paul, Minn.

By resolution passed at the last convention in Chicago, each member was requested to prepare three panels, one each of Tuscan red, straw color and olive brown, according to their own formula, expose them to the weather and report results in writing at this convention.

Foremen painters of all car and locomotive shops are invited to attend the convention.

National Electric Light Association.

For the following report of the Boston convention we are largely indebted to the courtesy of the *Electrical World*.

The convention was called to order on Tuesday, August 9, at 10:30 A. M., by President Morrison. After a short address setting forth the objects of the meeting the President introduced Mayor O'Brien, of Boston, who welcomed the members to the city.

The report of the Secretary and Treasurer was then read, which shows a balance of $842 in the treasury of the Association.

Mr. Arthur Stuart then read the report of the Legal Committee and Committee on Patent Legislation. The report recommended the establishment of a patent court to decide questions which are now subject to a scattered jurisdiction; and it also advocated appointment and promotion similar to that pursued in the Army and Navy, together with the pensioning of the examiners after a service of a certain length. In order to carry out these measures and bring them properly before Congress, the report suggested that the next meeting be held at Washington.

The report of Committee on Revision of By-Laws, I. J. De Camp, Chairman, was then read. After one amendment, allowing four representatives of one company to become members of the association instead of three, the report was made a special order for the Thursday session.

Mr. A. V. Garratt read the report on Wire Gauge, which was accompanied by a printed table. Mr. Garratt gave an account of the various authorities consulted in the construction of the table. After discussion by Mr. C. O. Mailloux and Dr. Moses, the question was made a special order for Thursday.

The Secretary then read the report on Proper Insulation of Wires and Proper Installation of Electric Light Plants.

The Committee consisting of Profs. E. J. Houston and W. H. Marks, Mr. Carl Hering and Mr. M. M. Garver reported that on account of lack of funds no experiments would be undertaken, but they formulated a code of tests for wires. On motion of Mr. W. W. Leggett, the report was laid on the table.

At the opening of the afternoon session, Mr. M. M. Slattery presented a report from the Committee on Electric Distribution by Means of Alternating Currents. The report was discussed by Mr. S. H. Duncan, Dr. Moses, Messrs. Kimball, De Camp, Smith and others and accepted.

Mr. E. R. Weeks then read a forcible paper on the subject of Electrical Education.

An invitation from the Boston Electric Club to visit Nahant, Lynn and Point of Pines by boat was received.

SECOND DAY.

On the second day Lieutenant Murdock, U. S. N., read a paper on Electric Light Outfit for Cruisers, which was followed by a brief discussion.

The resignation of Mr. Morrison, as President, was tendered, but was not accepted.

Dr. L. Waldo described some interesting apparatus for wire bending tests and gave data in regard to silicon-bronze wires.

Invitations to visit and inspect plant were read from the Meigs Elevated Railroad and the New England Telephone & Telegraph Company.

Mr. C. Cooper's resignation as Treasurer was accepted with regret.

The afternoon and evening were given up to the steamboat excursion, which closed with a dinner at Point of Pines.

THIRD DAY.

On the third day a large portion of the morning session was devoted to a discussion of various constitutional amendments. Among the speakers were Mr. De Camp, Dr. Moses and Mr. Phelps.

The report of the Committee on Wire Gauge was then taken up and briefly discussed. On motion of Mr. Phelps, it was received with the idea that the members should do as much as they could to encourage the making and ordering wire on the metric system.

At the closing session in the afternoon, an interesting paper was presented by Mr. C. O. Mailloux, on Storage Batteries.

Mr. A. Reckenzaun, of England, read an important paper

on Electricity as a Motive Power, discussing not only the subject of storage batteries, but their use with electric motors in propelling street-cars, launches, etc.

The papers were an epitome of work in this field to date, and contained a variety of striking figures. They were discussed together.

Messrs. S. A. Duncan, T. C. Smith and W. W. Leggett were chosen members of the Executive Committee, to succeed F. A. Gilbert, S. F. Holbrook and Dr. O. A. Moses, resigned.

Pittsburgh was chosen as the place for holding the next convention, in February, 1888.

The meeting closed with a brief talk, started by Dr. Leggett, on the underground question.

American Water-Works Association.

THE annual convention of this Association began in Minneapolis, Minn., July 13. At the opening session President B. F. Jones made his annual address, dealing with the question of pure water for the future.

The customary addresses of welcome were received and responded to. Mr. Y. Nakajinni, a Japanese engineer now visiting this country, was chosen an honorary member. Several new members were admitted.

Secretary J. H. Decker then read his brief annual report, showing 180 active and 51 associate members. The Association spent $675 during the year and received $905.

At the afternoon session the following papers were read: Ground Water as a Source of Supply; A. C. Sekell. Private Water Companies; H. F. Dunham. Recording Gauges; Charles A. Hague. There was a discussion on the use of Revolution Counters in computing pumpage.

An evening session was held, at which there were discussions on the Basis of Taxation of Water-Works Property and on the Relative Economy of Management by Private Companies and Municipal Corporations.

On the second day papers were read as follows: Natural Filtration; G. W. Pearsons. Filtration or Subsidence; J. D. Cook. Classification and Purification; M. Gardner. There was a long discussion on Filtration and the use of wells adjoining river supplies.

At the afternoon session three papers were read: Fungus or Mossy Growths; S. McElroy. Reservoirs, Open or Closed; G. E. Beach. Legal Aspects of the Water Question; G. E. Beach.

After the session the members visited the Falls of Minnehaha in carriages.

On the third day only one paper was read, on Property in Water, by A. H. Denman.

It was decided to print this paper of Mr. Denman and his treatise on the legal points in pamphlet form. A committee was appointed to prepare suitable eulogies on deceased members.

It was decided to hold the next Convention in Cleveland, O., April 13, 1888. The following officers were elected for the ensuing year:

President, J. T. Fanning, Minneapolis, Minn.

Vice-Presidents, J. M. Diven, Elmira, N. Y.; N. J. Milner, Birmingham, Ala.; J. W. Henion, Minneapolis, Minn.; J. P. Donahue, Davenport, Ia.; H. W. Ayers, Hartford, Conn.

Secretary and Treasurer, J. H. Decker, Hannibal, Mo.

Finance Committee, A. H. Denman, Des Moines, Ia.; B. Espy, Wilkesbarre, Pa.; C. N. Priddy, Leadville, Col.

After disposing of the routine business, the Convention adjourned.

The meeting closed by excursions to St. Paul and Lake Minnetonka; the annual banquet was held at the Lake.

Engineers' Club of Kansas City.

IN place of the regular meeting of August 1, this Club took an excursion on July 30, to Sibley, Mo., where the Chicago, Santa Fé & California road is to cross the Missouri River, by invitation of Mr. Octave Chanute, Consulting Engineer of the works. There were, including ladies and other invited guests, 52 in the party, which was taken to Sibley in a special car on the Wabash road. Mr. I. F. Wallace, Resident Engineer at the bridge, conducted the visitors to the scene of operations.

After examining the plans and materials and the arrangements for prosecuting the work, they were served a lunch. Subsequently, a few of the more adventurous members of the party descended into the caissons, from which they emerged, a few moments later, drenched and almost exhausted. They declared that the temperature of the outside atmosphere at 97° was wintry in comparison with the temperature (110°) which they experienced during their short stay in the caissons.

In the afternoon the guests were conducted aboard the contractor's steamboat by Mr. Sooysmith and took a short trip on the river.

The bridge proper will consist of 3 spans of 400 ft. each, 1 span of 250 ft., 1 span of 200 ft. and 2 spans of 175 ft. each, making the entire length of the main structure 2,000 ft. It will be approached on the north side by an iron trestle 900 ft. long and a wooden trestle 3,700 ft. long, making the length of the bridge, with approaches, 6,600 ft. in all.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, July 5, at which Professor A. N. Talbot, of the University of Illinois, was elected a member.

A resolution was adopted authorizing the President to appoint delegates to a Convention of Engineering Societies, whenever such a convention should be called, as proposed by the Board of Managers of the Association of Engineering Societies.

The Librarian announced the receipt of several new books, and was authorized to prepare and publish a catalogue of the library.

Mr. John Lundie read a paper—Notes on Concrete. This paper was discussed by Messrs. Artingstall, Williams, Gottlieb and others.

Council of Engineering Societies.

THE Council of Engineering Societies on National Public Works has issued the following circular:

"The Executive Board finds such a growing sentiment in favor of a broad and general consideration of the question of the policy to be pursued toward the public works of the country, both in the legislative and executive features, that it feels renewed encouragement in continuing its labors.

"The various societies are expected to continue their committees and be ready to consider any matter that may be laid before them; meantime any work which these committees can do, or any suggestions and results which they may lay before the Executive Board, will promote the general objects of this organization.

"A cordial invitation is extended to all societies, not now represented in the Council, to appoint committees on National Public Works. The Secretary will publish all necessary information."

The officers of the Council (which is an entirely different body from the Association of Engineering Societies) are: President, L. E. Cooley; Secretary, John Eisenmann, No. 44 Euclid Avenue, Cleveland, Ohio.

American Institute.

THE Polytechnic Section of the American Institute purposes enlarging its field of operation and popularizing its work by adding during the coming winter a course of familiar lectures on scientific subjects.

These lectures will be given on the first and third Thursday evenings in each month at the Institute Rooms in New York. The subjects will be announced from time to time. The regular meetings of the Section are devoted to short papers, discussions and exhibition of new inventions.

American Society of Mechanical Engineers.

THE Secretary, Mr. F. R. Hutton, gives preliminary notice of the annual meeting of this Society, which is to be held in the City of Philadelphia, Pa., in the latter part of the month of November. The exact date and details will be the subject of a later announcement, as usual. Applications for membership to take effect at this meeting should be in the Secretary's hands by October 1, to allow for the correspondence required by them under the new form of blank. To admit also of a little earlier distribution of the printed papers in advance of the meeting, to allow more time for the preparation of discussions upon them, which has been asked for, the MSS. of papers for this meeting should be forwarded to the Publication Committee before September 24.

The Secretary would like to have authors forward at once to him the titles of papers for the meeting, in advance of the prep-

aration of their text. This plan avoids the embarrassment to the Secretary and to authors which follows when the docket has to be kept in uncertainty up to the very limit of date. The Secretary's office is at No. 280 Broadway, New York City.

Master Car-Builders' Association.

The following notice has been issued from the office of the Secretary, No. 45 Broadway, New York.

"The circulars and cards for the letter-ballots ordered by the Master Car-Builders' Association at the Minneapolis convention have all been sent to members of the Association by mail. If any member has not received the circular, he will confer a favor on the Secretary by informing him at once.

"The subjects of the letter-ballots are: 1. Standard Type of Coupler. 2. Rigging for Non-Automatic Draw-Gear. 3. Standard Axles, Journal-Box, etc., for cars of 60,000 lbs. capacity. 4. Standard Sizes of Lumber for Freight Cars."

PERSONALS.

Mr. E. M. Leuffer is Chief Engineer of the new Buffalo & Geneva road in New York.

Mr. J. H. E. Waters is Chief Engineer of the projected Silverton Railroad in Colorado.

Mr. Albert M. Stahl has been appointed Assistant Naval Constructor in the United States Navy.

Mr. Edward P. North has been appointed Chief Engineer of the New Haven & Derby Railroad.

Mr. Joseph Broaddus is Chief Engineer of the projected Chicago, Kansas & Arkansas road in Kansas.

Dr. H. V. Ferrel, of Williamson County, has been appointed a member of the Illinois State Board of Health.

Mr. G. H. Randall has been appointed City Engineer of Fond du Lac, Wis., in place of N. Boardman, resigned.

Mr. D. H. Rhodes has been appointed Chief Engineer of the Wichita & Western Railroad, with office at Wichita, Kansas.

Mr. W. J. Murphy succeeds Mr. Benjamin Thomas as General Superintendent of the New York, Lake Erie & Western.

Mr. L. F. Billinger, C. E., has been appointed Professor of Engineering and Architecture in Norwich University in Vermont.

Mr. J. C. Turner, of Winchester, Va., is Chief Engineer in charge of the surveys of the projected Louisville, Cincinnati & Virginia road.

Mr. Horace G. Burt is appointed Chief Engineer of the Chicago & Northwestern road. He was recently Superintendent of the Iowa Division.

George G. McWhorter, Edward J. Vann and **William Hines** have been appointed Railroad Commissioners of Florida by the Governor of that State.

Mr. J. M. Meade has been appointed Assistant Engineer of the Eastern Division of the Atchison, Topeka & Santa Fé road, with office at Topeka, Kansas.

Mr. E. H. Johnson has retired from the office of Chief Engineer of the Chicago & Northwestern road, but will remain with the company as Consulting Engineer.

Chief Engineer A. H. Able, U. S. N., has been ordered on special duty in connection with the new cruisers now building at Cramp & Sons' shipyard in Philadelphia.

Mr. W. H. Baker has been appointed Assistant Engineer of the New Mexico Division of the Atchison, Topeka & Santa Fé road. with office at Las Vegas, New Mexico.

Mr. W. Gessler has been appointed Master Mechanic of the Southwestern Division, Chicago, Rock Island & Pacific Railway, to succeed R. O. Carscadin, deceased.

Mr. W. H. Earle has been appointed Assistant Engineer of the Middle and Western divisions of the Atchison, Topeka & Santa Fé road, with office at Nickerson, Kansas.

Mr. Benjamin Thomas has resigned his position as General Superintendent of the New York, Lake Erie & Western Railroad. He has been on the road nearly 40 years.

Mr. Harry Wilkins has been appointed Master Car-Builder of the Natchez, Jackson & Columbus Railroad, with office at Natchez, Miss. He succeeds Griffith Enders, deceased.

Mr. Benjamin Reece has been appointed Chief Engineer of the Toledo, Ann Arbor & North Michigan Railroad. He was recently on the Lake Shore & Michigan Southern.

Mr. Yokichi Yamada, who is Professor of Mechanical Engineering in the University of Tokio, Japan, is a graduate of the Stevens Institute of Technology, of the Class of 1876.

Chief Engineer Cipriano Andrade, U. S. N., has been ordered to special duty at Cramp & Sons' shipyard in Philadelphia, in connection with the new cruisers now building there.

The divisions of the office of the Chief of Engineers, U. S. A., have been placed under the charge of Major Charles W. Raymond, Major James C. Post and Captain Thomas Turtle.

Ensigns G. W. Street and **J. W. McKay,** of the U. S. Navy, have been selected by the Secretary of the Navy to take a course of study in France to fit them to become constructors in the Navy.

Mr. Sherburne Sanborn has been appointed General Superintendent of the Chicago & Northwestern Railway. He has been for several years Assistant to Mr. C. C. Wheeler, whom he now succeeds.

Mr. George B. Whiting will, it is stated, retire on October 1 from the position of Chief Draftsman in the Bureau of Steam Engineering in the Navy Department. Mr. Whiting has held the position since 1868.

Mr. Stevenson Towle, late Chief Engineer of Sewers, Department of Public Works, New York City, will sail soon for Europe to examine the systems of drainage and sewage disposal recently constructed there.

Captain John Ericsson, the well-known engineer and inventor, was 84 years old on July 31. He lives quietly at No. 84 Beach Street, New York, still spending his time chiefly in studying and experimenting.

Mr. W. L. Cameron, who has for over fifteen years been Secretary and Superintendent of the Memphis Water Company, has resigned the position of Secretary and been appointed General Superintendent of the Company.

Mr. Rudolph Hering, Chief Engineer of the Chicago Drainage and Water Supply Commission, is to examine and report on the sewerage system of the City of New York, under direction of the Commissioner of Public Works.

Mr. John M. Whitman is appointed General Manager of the Chicago & Northwestern Railway, succeeding Mr. Marvin Hughitt, who is now President of the company. Mr. Whitman has been for several years General Superintendent of the Iowa lines of the company.

Mr. D. F. Maroney, Manager car record office of the Baltimore & Ohio, has accepted the position of Associate Editor of the *Official Railway Equipment Guide.* Mr. Maroney is one of the foremost members of the Car Accountants' Association and has done much to advance the interests of that organization. He is the author of several excellent papers read before that Association.

George L. Perkins, Treasurer of the Norwich & Worcester Railroad Company, is undoubtedly the oldest railroad officer in this country, and probably in the world. Colonel Perkins was born August 5, 1788, so that he is now over 99 years old. He was chosen a director of the Norwich & Worcester Company in 1835 and Treasurer in 1837. Notwithstanding his great age, he is still active and attends punctually to the duties of his office.

Mr. Charles C. Wheeler has resigned his position as General Superintendent of the Chicago & Northwestern Railway, and retired from that office July 31. Mr. Wheeler has served on the road as General Freight Agent, Assistant General Superintendent and his late office for a number of years. His service has not been continuous, however, as he was for a time General Freight Agent of the Michigan Central, and from 1881 to 1883 General Manager of the Atchison, Topeka & Santa Fé. He will retire from active business altogether.

Chief Engineer George W. Melville, U. S. N., has been appointed Chief of the Bureau of Steam Engineering in the Navy Department in place of Commodore George B. Loring.

relieved at his own request. Mr. Melville was born in the City of New York, January 10, 1841, and is consequently in his 47th year. He was educated partly in the Academy of the Christian Brothers and partly in the Polytechnic School of New York. At the age of 17 years he entered the East Brooklyn engine shops as a machinist apprentice. Three years later, in July, 1861, he was appointed an assistant engineer in the Navy, and was soon ordered to duty with the flying squadron, serving first in the *Dakota* and then in the *Santiago de Cuba*, under Wilkes. From this vessel he was transferred to the *Wachusett* and promoted to passed assistant. He made two cruises in the *Wachusett*, and was in her when she took the Confederate *Florida* in Bahia Roads. The following year he was employed in torpedo service. After the war, Mr. Melville served in the *Chattanooga*, the *Penobscot* and the *Lancaster*. He was then chosen an engineer of the *Tigress* in the Hall Relief Arctic Expedition, after which he made a cruise in the *Tennessee*. Mr. Melville was selected as Chief Engineer of the *Jeannette*, and his exploits in the escape of her crew from the ice pack by way of Siberia have given him undying fame in the annals of Arctic enterprise. It is not disputed that but for the endurance and the unfailing courage of Melville no part of the crew of the *Jeannette* would ever have seen home again. He was again selected for Arctic service as Chief Engineer of the *Thetis* and fleet engineer of the Greely relief squadron under Commodore Schley. Under Secretary Whitney Mr. Melville's duties have been altogether on shore, in positions requiring particular expertness as a machinist. He was first detailed to superintend the preparation of the *Atlanta's* machinery for sea. Upon the beginning of the contract work on the *Baltimore*, the 1,700-ton gunboat and the dynamite cruiser at Cramp's yard, he was ordered there as Chief Inspector of Machinery. And from that duty he has just been promoted to the highest position in his corps. Personally the new Engineer-in-Chief is devoted to his profession and possesses, besides, a wide range of scientific attainments. He is a hard worker, an indefatigable student and has shown on trying occasions executive powers of the most commanding character.

NOTES AND NEWS.

Westinghouse Brake.—The London, Brighton & South Coast Railway reports that four accidents have, during the half year, been avoided by the use of the Westinghouse automatic brake.

Brazilian Railroads.—On December 31, 1886, an official statement gave the total length of railroad in operation in Brazil at 5,805 miles. At the same time there were 3,210 miles additional located and under construction.

Kansas City Water Works.—The National Water Works Company has nearly completed the new reservoir at Quindaro, near Kansas City. As soon as it is ready for use the supply for the city will be taken from the Missouri River, instead of the Kansas or Kaw River as at present.

Brooklyn Bridge Traffic.—During the month of July the number of passengers crossing the Brooklyn Bridge was 2,215,608, an average of 71,471 per day. Of these 209,889, or less than 10 per cent., were foot passengers, while 2,005,719—an average of 64,701 per day—were carried in the cars.

Steel Ties.—The Pennsylvania Railroad Company will put down 4 short sections between Pittsburgh and New York with steel ties and with very heavy rails, secured to the ties hy chairs. Careful watch will be kept of these sections to determine the relative cost and endurance of steel and wooden ties.

Fast Tracklaying.—Shepard & Winston, of St. Paul, Minn., contractors for the Montana Extension of the St. Paul, Minneapolis & Manitoba road, claim to have done the fastest tracklaying on record. In one day (July 16) their men put down 7.2 miles; in one week 29.8 miles and in one month 103.8 miles.

Natural Gas in Kansas City.—Perhaps the most important engineering project under way in Kansas City is the utilization of the natural gas already found within a radius of 40 miles from the city. Paola, at a distance of 36 miles from Kansas City, on the line of the Kansas City, Fort Scott & Gulf Railroad, offers at present the best supply, and a company has been organized to lay a line of pipes between the cities. Work will begin very soon. Mr. Edgar B. Kay is the Chief Engineer of the company.

Navy Yard Improvements.—The Secretary of the Navy has directed that $75,000 be expended for the purchase of tools and plant for the Brooklyn Navy Yard and a like sum for the purchase of tools and plant for the Norfolk Navy Yard. This action is taken under the act for the increase of the Navy, passed at the first session of the Forty-ninth Congress, which provides for the expenditure of $150,000 under the direction of the Secretary of the Navy, for improving the plant of such navy yards as he might select.

Poughkeepsie Bridge.—The following statement of the progress of work on this bridge is published: The false-works for the shore cantilever arms on both sides of the river are up, and the erection of the steel tower on Pier No. 1 has been begun. Pier No. 2 is nearly finished, the false-works adjoining it are finished and the traveler erected ready for work. At Pier No. 3, the top of the foundation crib is prepared for the grillage, which has been hauled out and set in place; this is a solid mass of timber 100 ft. long by 46 ft. wide by 14 ft. thick. Masonry has been begun upon it. At Pier No. 4, the concrete mixers are filling in the crib pockets. Pier No. 5 has not yet reached bottom, but is going down as fast as can be expected.

Electric Railroads.—The Kansas City Electric Railroad is now in successful operation. At present the line is about a mile long only, but it is to be extended through North Kansas City shortly.

The North & East River Railroad Company in New York City has its tracks through Fulton Street nearly all down. The electric conduit is nearly completed and will be put in place as soon as the material is received from Pittsburgh.

A new electric motor, designed by Stephen D. Field, has been put on the Thirty-fourth Street Branch of the Manhattan Elevated road. This motor derives its power from a central station, the current from the dynamo being transmitted through a central rail laid on the tracks of the road.

Corrugated Iron for Coffer Dams.—In a paper before the English Institute of Engineers on the Harbor Works in Algoa Bay, Cape Colony, Africa, the author, William Shield, mentions this novel use of corrugated iron: "Corrugated sheet-iron, No. 24 B. W. G. in thickness, formed the dams for the piers and south abutment, being stayed inside with timber framing and weighted with rails, so that the dams sank into the sand and gravel as the excavation proceeded inside. The dams for the piers were about 42 ft. long, 6 ft. wide and 8 ft. high; and they were perfectly water-tight. The author thinks that this, as he believes, novel use of corrugated iron will be found satisfactory and economical where, as in the present instance, clay is expensive and difficult to obtain of good quality."

Life-Boats for the Navy.—Naval Constructor Hichborn, who spent last week in examining the life-boats on vessels in New York, returned to Washington on Tuesday. The board of which he is a member visited many vessels at New York, both American and foreign, but failed to find a boat that excels the one now used by the Navy. The greater number of boats on foreign vessels are made of wood, with air tanks fore and aft. On American vessels there are many metallic life-boats. The boat used by the Navy is a large and commodious whale-boat with air tanks. In the opinion of Mr. Hichborn it answers every need of the service, and cannot be improved upon. It now awaits models of boats being made by Dobbins, of Buffalo Hatton, of Fort Covington, N. Y., and Captain F. L. Norton —*Army and Navy Register.*

Telephones in Europe.—The *Electrical World* says: "We present some remarkable figures as to the use of the telephone in four European countries—Belgium, Holland, Italy and Russia. The tables give a list of the exchange subscribers in each country. The total of such is, allowing for a few untabulated exchanges, about 19,000. In other words, in these countries, with a total population of 136,000,000, there are only 19,000 subscribers all told, or 1 in every 7,158; while in the United States there are 147,000 subscribers in a population of 50,000,000, or 1 in every 340. The disparity is remarkable. There are as many telephone subscribers in New York and Brooklyn as in all Italy with its 28,000,000 of people; as many in Boston as in Holland with its 4,000,000; more in Chicago than in all the dominions of the Czar."

Electric Mine Railroad.—The Union Electric Company, through its electrician, Mr. W. M. Schlesinger, has made a successful electric railroad installation in the Lykens Valley, Pa., coal mines. The track is wholly within the mine and is about 6 000 ft. long. It includes a 25-ft. curve and a 30-ft. curve. The grades in most cases are slightly in favor of the load, but there are many places entirely level and long stretches of up-hill work, one grade of 1½ per cent. being reached just in front of the 25-ft. curve. The first run in was made recently. The motor met a loaded train coming out; the mules were

taken off the cars, and the motor then hauled them easily the rest of the way out—1,800 ft. Next day the train hauled out the load. The entire train weighed 112,000 lbs. The road appears to be highly thought of by practical miners.—*Electrical World*

Railroad Stations.—It is interesting to note the growing importance attached to the architecture of railroad stations. This idea is suggested by the recent news that the Fitchburg Railroad Company has accepted the plans of Hartwell & Richardson, of Boston, for a handsome depot to be erected at Waltham, Mass., at a cost of $25,000. A few years ago, railroad depots were an eyesore to passengers; they were presumably erected from orders of the engineers of the road, whose education, of course, was hardly in the line of architecture, except in its most practical sense. A new era, however, was opened when McKim, Robertson and the late H. H. Richardson were called upon to prepare designs. The West Shore Railroad had some unique and picturesque designs on its road, and the directors of railroads generally seem to appreciate the fact that utility can be combined with what is pleasant to the eye.—*Building.*

A New Armstrong Gun.—A new gun for the Royal Navy, invented and manufactured by Sir William Armstrong and Co., at Newcastle-upon-Tyne, has just been tried at the range of the company at Silloth, Cumberland. The gun is a 30-pounder, and its weight with carriage is 92 cwt. It is specially designed for the purpose of repelling torpedo attacks, and it is stated that it can be worked much quicker than the guns of the present size. The carriage is fitted with Vavasseur's patent automatic machinery, and the gun can be instantly elevated or depressed or swung round to any given point. The trial proved very successful. The gun was fired by electricity, and the velocity of the projectiles, as taken by an electric chronograph connected by wire with the muzzle of the gun, was ascertained to be 1900 ft. per second. Proof shot, common shell and shrapnel shell were used, and the firing charges contained 9 lbs. of pebble powder. The gun will shortly undergo another trial before the officials of the Admiralty at Portsmouth.

Simple versus Compound Portable Engines.—In commenting on the merit trials of portable engines at the Newcastle (England) show, *Engineering* says: "To our minds the most important lesson taught by the trials is the undoubtedly superior economy of the compound portable as compared with the non-compound engine. The compounds had, it is true, the advantage of higher steam pressures, but this was not at all sufficient to account for the extra economy, amounting to to some 28 per cent. That a non-condensing compound engine working with 150 lbs. steam can be made to work with a consumption of 1.8 lbs. of coal per brake H. P. per hour—equivalent to a consumption of about 1.55 lbs. per I. H. P.—will be regarded as little short of a revelation in many quarters, while it is a result which very few engineers would have cared to prophesy. Of course, we are not losing sight of the facts that the coal used was of very high quality and carefully selected, and that the stoking was quite exceptional in its excellence; but even allowing for these facts the performance is a most remarkable one."

Hotchkiss Guns.—The Hotchkiss Ordnance Company has made arrangements to establish a factory in the United States (probably in Connecticut), having made some heavy contracts here. In relation to this contract the Secretary of the Navy says:

"Our secondary batteries have heretofore been made abroad, and the creation of an establishment for their manufacture in this country will mark another and a most important era in the reconstruction of the navy. When Mr. Hotchkiss died in 1884, England, France, Germany, Russia Italy—every important European Power, in fact—had an establishment for the manufacture of Hotchkiss ordnance. By delaying for a time the purchase of ordnance of this character, we are enabled to tender contracts for a large supply. The company's investigations have elicited the fact that, taking the superiority of American machinery into consideration, the guns may be made as cheaply here as abroad. It was a matter of necessity with us either to set up a manufactory of our own or get the Hotchkiss Company to come here, since we can no longer afford to be dependent upon other countries for our war material. Machine guns have been an indispensable branch of naval armament.

"The six-pounder rapid-fire Hotchkiss gun requires but one man to control it, is fired from the shoulder and discharges 23 shells per minute, with a velocity sufficient for the penetration of a 2-in. steel plate 1,000 yards distant. These guns are specially serviceable against torpedo boats, unarmored ships and in clearing the exposed decks of ironclads. The company is now developing a nine-pounder and is experimenting with a thirty pounder. With the Bethlehem Iron Company contract and this one executed, American shipbuilders will be able to build and arm war-ships entirely from American manufactories."

Flanged Frame-Plates for Locomotives.—Frame-plates for railway rolling-stock have hitherto been made up of pieces of material riveted together, or the frames of wagons or carriages have been made partly of iron and partly of wood. Mr. Samson Fox, of the Leeds Forge Company, Leeds, has, however, produced, simply by hydraulic pressure, flanged frame-plates. These plates, noteworthy examples of worked steel, are fashioned at one heat by hydraulic pressure, and are provided with facing strips for the attachment of the necessary fittings. The object sought is to produce a frame-plate sufficiently rigid, transversely and longitudinally, without the necessity of angle-iron stiffeners, and, at the same time, to reduce the cost of the manufacture, and in this the Leeds Forge Company has succeeded. The flanged frame-plate is in one piece, and is more serviceable and enduring than a frame-plate built up in sections. It also possesses the recommendation of being an article which can be produced of exactly the same size a thousand times over. The frame-plates exhibited by the Leeds Forge Company at the Manchester and Newcastle exhibitions are 21 ft. 9 in. long, and are provided with three axle-box guides of the Northeastern Railway Company's standard tender-frame pattern.—*Iron.*

Blast Furnaces of the United States.—The *Iron Age* gives the condition of the blast furnaces on August 1 as follows:

	In blast.		Out of blast.	
Fuel.	Fur.	Capacity per week.	Fur.	Capacity per week.
Charcoal	67	11,533	107	8,364
Anthracite	129	37,930	68	15,058
Bituminous	113	62,091	96	41,345
Total	309	111,554	271	64,767

As compared with last year, the number of furnaces in blast and their weekly producing capacity (in tons) on August 1 was:

	1887.	1886.
Furnaces in blast	309	313
Weekly capacity	111,554	122,042

The *Iron Age* says: "During the month of July quite a number of changes have taken place in the direction of reduced current output among those using anthracite as a fuel, while there has been a resumption of work among the coke stacks, following the settlement of the strike. Quite a number of the latter had not begun blowing on August 1, which have since entered the ranks of producers, so that the current month will probably witness a gradual increase in the make. With the anthracite furnaces the decline in the make is nearly 3,000 tons a week, and we entered August with the lowest current output since the opening of the year.

Baltimore & Ohio Employes' Relief Association.—The June sheet issued by this Association shows payments of benefits to members during the month as follows:

	Number.	Amount.
Accidental deaths	9	$9,000
Accidental injuries	334	4,081
Natural deaths	6	1,500
Sickness	533	7,714
Physicians' bills	184	1,332
Total	1,066	$23,627

The Library Committee issues the following: "Through the generous assistance of the officials of the railroad company and others interested in its welfare, the Baltimore & Ohio Employés Free Circulating Library will very shortly purchase about 4,000 additional volumes of carefully selected and interesting books, which will necessitate the compilation of a new catalogue. For this purpose all Library books must be in the hands of the Librarian as soon after July 1 as possible, and those works now in circulation should immediately be returned.

"The preparation of a catalogue being a work of much labor and requiring considerable time, the Library will be closed from July 1 to September 1 and during the interval no books will be issued or access allowed to the Library room. All requisitions will be filed in order of receipt and books furnished therefrom commencing September 1. Applications for new catalogues, accompanied by the subscription price (25 cents), will be received after August 15, 1887."

A Mississippi Theory.—The Falls of Niagara are familiar to all, and came to exist through causes natural and easy of explanation, inasmuch as the whole secret lies in the character of the formations over which the river flows, viz.: a

crust made up of 60 to 100 ft. of comparatively hard limestone lying in a nearly horizontal position, beneath which is a deep deposit of shales and sandstones. Whenever the river, in wearing its channel back, reached the point where this arrangement of rocks began, the hard limestone would naturally resist the erosive action of the waters, while the underlying shales and sandstones, offering less resistance, would be rapidly cut away, until a vertical fall such as is now seen would be the result, with a constant recession going on, leaving below the broad cañon, walled on either hand by bluffs, the crests of which are preserved by the limestone crowning them.

These few reflections as to the falls and gorge of Niagara, fully demonstrated by forces now in active operation, we shall apply to the Mississippi. Here also a mighty waterway has been cut out by erosion, a fact which is universally conceded, but no definite explanation of the process has heretofore, so far as we have been able to learn, been advanced. It remained for a geology-reading inventor by the name of Robert Bates to suggest a theory which, illuminated with what little investigation we have been able to give it, promises to offer a solution of the question, or to assist in its solution. The theory briefly is, that the erosion was accomplished by means of a mighty cataract which began far down the river near its original mouth, and by gradual retrocession dug out the valley-like gorge which is so marked a feature in the upper part of its course, and left the high bluff walls on either hand, at the same time depositing heavy beds of sand at the bottom of the cañon, the product of the erosion above, and that St. Anthony Falls are the ever decreasing and receding remnants of the once most stupendous cataract the world ever saw, having a perpendicular descent of perhaps 600 ft.—*John A. Keyes, in Popular Science Monthly for August.*

Boiler Explosions in France.—We give below a summary of the bulletin published by the Ministry of Public Works in relation to accidents caused in France in 1885, by the use of steam apparatus.

The following table is a division by kind of apparatus:

1. Boilers with exterior furnaces:

	No.	Killed.	Injured.
Horizontal, not tubular, with or without flues	8	24	21
Horizontal, tubular	2	2	..
Vertical	1	..	..
2. Boilers with interior furnaces:			
Horizontal, not tubular	1	3	7
Horizontal, tubular	1	..	..
Vertical	2	1	..
Total boilers	15	30	28
Receivers or heaters	9	4	5
Miscellaneous	1	..	..
Total	25	34	33

The total number of explosions was thus 25, by which 34 persons were killed and 33 seriously hurt; slight injuries are not included.

A division according to the supposed causes of accident is as follows:

Defective construction, material or placing	5
Fatigue, weakening or corrosion of metal	7
Repairs neglected or badly made	2
Low water	6
Too high pressure	4
Other cases of neglect or imprudence	6
Miscellaneous	2

It will be seen that the total number of supposed causes is greater than that of accidents. This is due to the fact that in several cases an accident was attributed to two or three different causes working together.—*Portefeuille Economique des Machines.*

Copper Mines in Japan.—A report recently made to the British Foreign Office on the Ashiwo copper mines in Japan says that the work is conducted under the general management of an engineer from the Imperial College of Engineering in Tokio, and over 4,000 miners are constantly employed. In addition to the reduction works and sulphate of copper factory, there is a complete shop for repairing all machinery, and all the different branches are connected by telephone. Owing to the expense connected with the transport of ore from an isolated working, a tunnel is being bored to connect it with the main lodes, the length of which will be 11,880 ft. In connection with this, a steam rock drill of 10 H. P. was started last year and is working satisfactorily. At present two Shrenne rock drills are being used in driving this heading, and four others are on their way from Germany. Dynamite is used for blasting, and the shots are fired by electricity. The present plant in the reduction works consists of 2 crushing rolls, 8 stamping mills of five heads each, 42 jiggers, 8 percussion tables, 9 sieves and 3 steam engines of a total of 68 H. P. Hitherto the machinery employed has been procured from England, France and Germany; but, as a German metallurgist has recently been engaged, it is more than probable that, in accordance with a general custom, all orders will in future go exclusively to Germany.

Railroads in Sweden.—A note in the *Annales de Ponts et Chaussees* says that what characterizes the establishment of railroads in Sweden is not only the cheapness with which they have generally been built and operated, but also the variety of gauges adopted. Nowhere else, except perhaps in Norway, has there been tried on so large a scale the experiment of the narrow-gauge, varying from 4 ft. to 28¼ in.

The length of completed line is divided among the different gauges as follows:

Guage.	Mileage.
4 ft. 8½ in., Standard Gauge, 39 lines in all	1,758
4 ft., 4 lines	1,030
3 ft 8 in., 1 line	57
3 ft. 7 in., 2 lines	30
3 ft. 6 in., 4 lines	137
2 ft. 11 in., 18 lines	435
2 ft. 7½ in., 2 lines	64

The lines under construction or projected are to have the following gauges:

Gauge.	Mileage.
4 ft. 8½ in.; 14 lines	543
3 ft. 3⅜ in., (1 metre), 1 line	117
2 ft. 11 in., 7 lines	10
2 ft. 4¼ in., 1 line	3

There are thus in Sweden eight types of narrow gauge, but that which tends to increase the most is the 2 ft. 11 in. gauge, which will soon have a total length of 552 miles, or over 60 per cent. of the narrow-gauge mileage.

On the roads of standard gauge the minimum radius of curvature is generally 975 ft.; on some of the lines, however, this is reduced, notably on the Banghammar line, near Kloten, where the minimum radius is 684 ft. On the narrow-gauge lines the minimum radius of curvature is 487 ft. Swedish practice follows the English rather than the American as to curvature, as well as in other points.

The cost of the standard-gauge lines has varied from $14,800 to $50,500 per mile; that of the narrow-gauge lines from $8,100 to $33,250 per mile. The roads generally have been cheaply built.

Loss of Heat from Steam Pipes.—The *Locomotive* reports as follows some practical tests to ascertain the loss of heat from uncovered steam-pipes and those covered with different coverings, made by Superintendent Upson and Chief Engineer Steele, of the Hartford Carpet Company:

"A room having a very even temperature and free from draughts or air currents was selected, close to the boilers, where steam could be taken from the top of the main pipe, and free from water of condensation. A suitable vessel was arranged to collect the water of condensation, and connected to 120 running feet of 2-in. steam pipe. A short section of the pipe was enclosed in a suitable box with a glass in the side for the purpose of reading the rise of temperature, as indicated by a thermometer placed therein.

"Steam was first blown through the pipe and receiver until both were free from the water of condensation which was caused by heating the pipe and receiver. The valve was then closed, and 10-hour trials made, the water carefully collected and weighed, with the following results:

"1. The first trial was with 120 ft. of 2-in. pipe, uncovered, results as below:

Average steam pressure	70 lbs.
Average temperature of room	70 deg
Average temperature of box	167 "
Water condensed	162 lbs.

"2. The second trial was with 120 ft. of 2-in. pipe, covered with asbestos, hair-felt and paper, results as below:

Average steam pressure	77 lbs.
Average temperature of room	69 deg.
Average temperature of box	80 "
Water condensed	222 lbs.

"3. The third trial was with 120 ft. of 2-in. pipe, covered with plastic material, results as below:

Average steam pressure	80 lbs.
Average temperature of room	70 deg
Average temperature of box	107 "
Water condensed	480 lbs.

"It will be seen from the above that the loss by radiation greatly exceeds that usually estimated for uncovered pipes, but it agrees very well with trials made upon machines carrying high steam pressures. The saving by covering the pipes is very satisfactory, and in the second trial the temperature in the enclosed box was but little higher than that of the room."

A Gas Accident.—The London *Engineering* says: "As a timely reminder to those whose business it is to look after the safety of railway travelers, it will not be out of place to mention the painful accident which has just occurred on the Berlin-Potsdam Railway, the third fatal one, it may be noted in passing, which has taken place on the line in recent times. It appears that an empty goods train was prematurely signaled

into the station at Waansee, and ran into a standing excursion train waiting to return to Berlin, when a smash took place which caused the reservoir of gas under one carriage to explode while the locomotive of the goods train caused the gas to ignite, which flew about in all directions and over the cushions, and set fire to everything inside the carriage in which three persons were caged, and could neither escape nor receive assistance from without on account of the build of the carriage, and were in the most incredibly short space of time burnt to an actual cinder. The only remnant of the male passenger appears to to have been part of his waistband by the buttons of which it is hoped to recognize his personality. The obvious moral to be drawn from this sad catastrophe is, that where gas is used on railroads the reservoir of it must be so placed and formed that under no circumstances, can it be smashed by a collision or the gas ignited if such should take place. The gas receiver in this case was a long sheet-iron drum, placed transversely beneath a second-class carriage."

Russian Railroads in the Caucasus.—Two important events have occurred in connection with Russian railroads in the Caucasus. The Novorossisk tunnel, which has been 15 months in hand, has been successfully pierced, and there is every prospect, therefore, that the line from St. Petersburg to this Black Sea port (Batoum), will be completed by the time stipulated this spring. The tunnel is 4,500 ft. long, and had to be excavated through the solid rock. Owing to the strategical importance of the line the Government has been pressing on the work at any cost. When complete, it will be possible to send troops from any part of Russia to this Cis-Caucasian port, and not only prevent invasive operations on the coast in the event of a war with England, but provide a means of sending troops against Turkey from a new quarter in the event of Russia being able to block the Bosphorus and control the Black Sea. Regarding the commercial importance of the line it traverses the Black Sea petroleum region, and thereby lays it open to European enterprise.

The second event of importance is the decision of the Russian Government to provide a credit for 3¼ million roubles, to be expended in adding 18 locomotives and 1,296 freight cars to the rolling stock of the Transcaucasian Railroad. This remarkable addition demonstrates the rapid growth of traffic on this road, which has been so great that camels were for a time requisitioned to convey goods from the Caspian to Tiflis, alongside the line, to ease the excessive traffic. It is popularly supposed that the bulk of the traffic on this railroad consists of petroleum, whereas last year this only composed a third of the general total. The fact of the matter is that the opening of the 700 miles of line from Krasnovodsk to the Oxus, on the Central Asian side of the Caspian, has tapped the large trade with Russia existing *via* Orenburg, and has attracted it to Baku and Batoum. The whole of the 1,296 cars and 18 locomotives are to be made in Russia and sent to Transcaucasia with as little delay as possible. In the meantime fresh arrivals of petroleum tank cars are reported, the refiners at Baku readily availing themselves of the newly accorded privilege to run their own oil cars on the line. The firm of Nobel is introducing 600 or 700 of them, each conveying 10 tons of petroleum.

Transmitting Power by Electricity.—A plan has been proposed for transmitting power by electricity to the City of Valencia in Spain, which is a manufacturing town of importance. The power is to be obtained from the River Turia, about 35 miles from the city, at a point where the stream describes roughly a semi-circular arc. Along a chord of this arc, measuring 1.37 miles in length, it is proposed to cut a canal, at an almost horizontal level, thus obtaining at the outlet a fall of 108 ft. to the bed of the river. The line of the canal is, however, intersected by a range of rugged hills, under which it will be necessary to tunnel for a distance of rather more than one mile. The intake will be effected at a point where the river issues from a deep and narrow ravine (the Pass of Cingdos), and this configuration offers peculiar advantages for impounding the flow and constructing the necessary dam and sluices. At the farther end of the canal the ground is favorable for the construction of a reservoir upon the higher level, and for the erection of the machine-house upon the river bank.

The mean annual volume of water to be dealt with is stated, after numerous experiments, to amount to 353 cubic ft. per second, which, under a head of 108 ft. will be found to account for 4,200 horse-power (theoretical). It is proposed to utilize this force by means of Jonval turbines, for which an efficiency of 70 per cent is assumed, thus yielding a brake horse-power of 2,940, or, say, 3,000.

This 3,000 H. P. will be transmitted to Valencia by electricity, and the projectors have calculated a large return on the investment required. The cost of the dam and other works is estimated at about $665,000. The details of the method of transmission have not been fully worked out.

Phosphor-Bronze Wire for Helical Springs.—At a recent meeting of the Engineers' Club of Philadelphia, a note by Mr. Wilfred Lewis on Phospho-Bronze Wire for Helical Springs was presented as follows:

"About a year ago, in designing valves for hydraulic machinery, it became necessary to use springs in the water ways, and to guard against corrosion, it was suggested that they be made of phosphor-bronze.

"No information, however, could be found for determining the proper size of wire and its probable extension or compression, and accordingly the writer undertook to make the following partial solution of the problem. A piece of wire No. 12 diameter and several feet long was obtained from our fellow member, Mr. Lüders, for the special purpose mentioned, and coiled in the form of a spiral spring 1¼ in. in diameter, from center to center, making 52 coils.

"This spring was loaded gradually up to a tension of 30 lbs., but, as the load was removed, it became very evident that a permanent set had taken place. According to formulæ recommended by D. R. Clark for helical steel springs, such a spring of steel should bear with safety a load of 20 lbs., while, according to the practice of the Pennsylvania Railroad, it might be used for double this load, or 40 lbs.

"A weight of 21 lbs. was then suspended from the bronze spring, so as to allow a small amount of vibration, and the length measured from day to day.

"In 30 hours the spring lengthened from 20⅝ in. to 21⅛ in., and when suspended 200 hours, its length was found to be 21¼ in.

"It was concluded from this that 21 lbs. was too great for durability, and that probably 10 lbs. was as much as could be depended upon with safety.

"For a given load it was found that the extension of the bronze spring would be just double the extension of a single steel spring; that is, for the same extension, the steel spring is twice as long,

"The above experiment is not very conclusive, but my practice now is to allow for phosphor-bronze springs the same extension or compression as for similar steel springs, and let them carry one-half as much load."

Effects of Explosives.—At a recent meeting of the Royal Society of Edinburgh, Professor Tait made some interesting and suggestive remarks on the effects of explosives—a subject having some connection with lightning flashes. The singular fact had been stated in the newspapers that an explosion of dynamite in the Underground Railway in London produced the excessively curious effect that several persons within a certain range had the drum of one ear ruptured, while no effect was produced on the drum of the other ear. If he had not been thinking for years about the effect of lightning flashes upon the air, he must have set down this to newspaper reporting. The difference between the effect of a sudden explosion in the immediate neighborhood of the center at which the explosion took place, and the effects of the same at a moderate distance, might be perfectly different from one another; and when examination was made of the matter from the physical point of view it was found that the difference depended on this: that as long as the projectile matter—whether it was the air itself around the explosive, or the materials of the explosive which were driving it from the center of explosion—were going at a velocity greater than sound, the effect of their motion was precisely the same sort of thing as is observable in the case of a falling star. It compressed and immensely heated the air immediately in front. So long as it exceeded the velocity of sound, there could be no vibration propagated beyond the limit to which the explosion had extended, and the gases only came, as it were, into contact with a dead stone wall of stationary air outside. The result was that the air was compressed and became self-luminous by the instantaneous compression. So it was with lightning. Up to the point at which the velocity became that of sound there would be an exceedingly intense impulsive pressure, and there was great danger of very considerable damage. The question of how much force was required to rupture the drum of the ear was a question for physiologists. Being asked by Dr. Wallace how it was that, for explosive purposes, gunpowder required to be inserted into the material to be exploded, while dynamite was placed on the top, Professor Tait replied that dynamite exploded with great rapidity, and the consequence was that the gases expanded with exceeding rapidity, whereas gunpowder was burnt comparatively slowly, and produced the effects of increased pres-

sure with graduated speed. If the velocity was much greater than that of sound there was percussion, otherwise there was nothing but the propagation of vibration. It was the difference between a wave and a breaker.

The Latrobe Corn-Stalk Columns.—In the vestibule of the Capitol at Washington, beneath the office of the Marshal of the Supreme Court, are the only truly American columns in existence. If the student of architecture regrets that this country has not produced any architectural effort of its own, he should be referred to this work of Benjamin Henry Latrobe, who succeeded Messrs. Hallett, Hadfield & Hoban as the Capitol Architect and perfected the designs of Dr. Thornton. In a letter of Latrobe's to Thomas Jefferson he refers as follows to his designs: "I have packed up and sent to Richmond, to be forwarded to Monticello, a box containing the model of the columns to be used for the lower vestibule of the senatorial department of the north wing of the Capitol, which is composed of ears of maize. * * * These capitals, during the summer session, obtained me more applause from the members of Congress than all the works of magnitude or difficulty that surround them. They christened them 'corn-cob capitals;' whether for the sake of alliteration I cannot tell, but certainly not very appropriately."

This letter was addressed to Mr. Jefferson, and bears the date of August 28, 1809. Latrobe, not Jefferson, was the designer of the pillars. Many considered the latter to be their parent, because he teok such an interest in the erection of the Capitol, and is known to have proposed many changes to the architect. Jefferson spoke to Latrobe of the lack of individuality in our public buildings, and asked why he did not conventionalize some of our native vegetation into appropriate columnar designs. Doubtless acting on this, Latrobe produced the corn-stalk columns which now stand in a somewhat unnoticed portion of the Capitol. Each column is composed of a cluster of Indian corn-stalks bound together so that the joints of one stalk stand slightly above the preceding one; thus, by the recurrence of the joints in the seven divisions of every stalk, a spiral effect is produced. The capitals are composed of ears of maize with the half-open husks displaying the corn, which in its upright position has been criticised as being too stiff.

Whatever the faults of the original pillars may be, they are a bold stride toward forming for ourselves an ornamentation peculiarly in keeping with our new and vigorous Government. That our buildings have to be supported by Doric, Ionic and Corinthian columns, unrelieved by anything of our own conception, is strange, when we consider the independence of the people of the United States. We have given to the Old World our mechanical inventions, the benefits of scientific research, yet we borrow from the East all our architectural forms.—*Eugene Ashton, in the Magazine of American History for August.*

The Wagner Free Institute of Science.—This Institute was founded by the late William Wagner, a citizen of Philadelphia, who devoted a long lifetime to the study and advancement of the sciences, especially the different branches of natural history. Mr. Wagner, during his life, formed a large museum, a library, and a collection of chemical and physical apparatus. He established annual courses of lectures on various scientific subjects, in which he personally took an active part, which were continued for thirty years, and which were always open free to the public. In 1855, under the above name, the institute was incorporated by an act of the Legislature.

Mr. Wagner bequeathed his property to the Institute, vested in a board of trustees. Since his death in January, 1885, the trustees have been actively engaged in carrying out his plans, and in accordance with his views, have elected a faculty of four professors to take charge of the museum and library, to give lectures free to the public, and to teach the method of, and also to make, research. The first annual course of free lectures was given by the faculty during the season of 1885 and 1886. The sphere of usefulness of the Institute will expand as the pecuniary circumstances are adjusted and will permit. That the benefits of the Institute shall not be restricted to its locality, but may be widespread as possible, the trustees propose to make provision in aid of original research and the publication of its results, towards the increase and diffusion of knowledge among men.

Mr. Joseph Wilcox, one of the trustees, who had spent several successive winters in Florida, in speaking of his observations in that State, suggested the interest it would be to the Institute and to Science to make an expedition to certain portions of the country, to make collections and investigations in their geology and fauna. Liberally offering his pecuniary and personal aid, and encouraged by the Academy of Natural Sciences, the trustees of the Institute made the necessary provision, and last winter sent Prof. Heilprin on the proposed expedition in company with Mr. Wilcox. The results were valuable collections in zoology, and especially in geology, together with important investigations and discoveries in the latter, an account of which is presented in the report by Professor Heilprin, which has just been published as Volume I of the *Transactions* of the Institute. The well observed facts of the report must greatly modify the opinions which have been generally held in regard to the geological construction of the peninsula of Florida; and altogether Prof. Heilprin's researches must be considered as an important contribution to Science.

An English Electric Car.—A tramcar of the Jarman pattern, carrying 46 passengers, was recently tried at Brixton. The electric motor is placed under the tramcar between the axles, and the storage battery is distributed under the seats of the car. In Mr. Jarman's motor excessive heating is prevented by means of two armatures, which are fitted on one axle. One of these armatures drives the car in one direction and the other propels it in the contrary direction, so that each armature has time to cool down should it become heated on a journey. The storage battery consists of 70 E. P. S. cells, the contents being 195 ampère hours, or equal to a run of about 20 miles. The cells are charged in the usual way by a stationary dynamo at the depot, as may be found necessary. The weight of the car with its electro-motor and storage battery complete is about 5 tons 6 cwt., the car itself weighing 3 tons. It is driven from either end and is fitted with a very effective friction brake, which grips the axle of the motor. The car is lighted by electricity, and is fitted at each end with a brush for clearing obstructions off the rails. The experimental runs made with this tramcar were very satisfactory, so far as the shortness of the line would permit. The line is laid with a sharp curve of 43 ft. radius, which was easily traversed, and an incline of 1 in 40, which was readily mounted, and on running down which some good stops were made. In running upon the level at a fair speed the car was pulled up dead in half its length and showed itself to be well under the control of the driver. It had on a previous occasion made a trial run, loaded with 52 passengers, from Brixton to Westminister Bridge and back, with what are stated to have been very satisfactory results, a high rate of speed being attained and the car being run from the tramway to the works at the finish over the macadamized road without detriment.—*London Times.*

Engineering in Palestine.—In a review of Mr. Oliphant's book "Haifa; or Life in Modern Palestine," the London *Times* says: "The author makes mention of two grand engineering projects, one of them plausible and practicable, the other very much in the air. The first is the Great Palestine Railway, which has been surveyed from Haifa as far as the Jordan. The concession is held by a knot of gentlemen, some of them Moslems, others Christians, but all subjects of the Porte. His opinion is that it is 'a real, *bona fide* enterprise, and one which is likely to become a large source of profit, * * * for it will tap one of the richest grain-producing districts of the East.' The surveyors see no serious engineering difficulties. It crosses the Kishon by a 60-ft. bridge, it runs smoothly over the wide plains of Esdraelon, and there will be a station, or rather a junction, for Nazareth. The Jordan Valley Canal is a more ambitious scheme, nor do the estimates appear to be so absolutely reliable as to tempt the cautious investor. Optimists set them down at £8,000,000 sterling, while unfriendly pessimists carry them so high as £225,000,000. 'The whole length of the canal would be 250 miles, of which, however, only about 120 would be actual cutting, but cutting of a nature unparalleled in the history of engineering.' The idea is to flood deep depressions of the Jordan Valley with the waters of the Mediterranean and to connect the Dead Sea with the head of the Red Sea at Akaba. It is hardly necessary to speculate on the probable traffic, for, setting financial hitches aside, the sentimental and political difficulties would seem to be insurmountable. The canal would swamp the Lake of Tiberius, and sink the scenes of the Savior's Galilean ministration 500 ft. beneath sea level. By making English influence predominant in Palestine it would provoke the opposition of France and Russia; and if it should really prove an engineering success it would ruin the Suez Canal and the shareholders. As for the Sultan, he might possibly be tempted by the sums of ready money which he would receive in exchange for submerged territory. But, on the other hand, he would have to resign himself to part with another province, since Palestine would be virtually annexed by the English. Jericho would be submerged with other places, and that would be a pity, for, according to Mr. Oliphant, there is a fair prospect of the 'City of palm trees' rising into reputation as a winter watering place. Aristocratic Russian pilgrims bound to bathe in the Jordan

have taken it under their patronage; very comfortable quarters are already to be found in a large building erected for their special accommodation; and for those who prefer a quieter and more domestic life clusters of neat little cottages *ornées* have been run up. Jericho may be dull, but it has its recommendations. 'There is a peculiar softness and balminess in the air not to be found elsewhere in the world, for there is no other place in the world 1,100 ft. below the sea line.' For the friends of the invalid there is good galloping ground on the plains and wild shooting in the thickets between Jericho and the 'swellings of the Jordan,' and the Ottoman authorities appear to believe in the future of the place, for they are actually bestirring themselves over improvements and reclamations in the neighborhood."

The Nordenfelt Torpedo Boat.—A trial of the *Nordenfelt* submarine boat built for the Turkish Government was recently given before the Sultan at Constantinople, and is thus described by a correspondent of the London *Times*: "The order to leave her moorings reached the *Nordenfelt* at 2 p. m. The boat was lying at the time under banked fires, and within 20 minutes she was under way, proceeding down the Golden Horn at a rapid rate, piloted by two steam launches. She showed her remarkable steering qualities by the manner in which she threaded her way among the numerous lighters and smaller craft that would hold their course in spite of warning whistles and shouting. As she shot the bridge, no easy task in a long craft with a current setting across the opening, a loud murmur of surprise and admiration arose from the crowd of spectators attracted by the desire to see the wonderful boat which, according to rumor, can travel as well under the sea as on the top of it. The boat at the time was in her surface condition—that is, with her funnel up, so as to keep in play the furnaces of the ordinary boiler, and more or less of the hull showing for its full length. Painted as she is of a light gray color, even in this condition, however, it was no easy matter to see her at any great distance, as there was no smoke issuing from the funnel to attract the eye. Arriving off Seraglio Point, the boat stopped, awaiting the orders of the Sultan, who had notified his intention of personally directing the manœuvres. Here, in the very worst part of the current, she easily maintained her position with a few turns of the screw, while her attendant launches were obliged to seek the shore. The order having been given to attack, as a surface boat, a merchant steamer lying off the Scutari shore, the *Nordenfelt* rushed ahead at full speed. End-on, the target she presented was remarkably small, only a dome with a bit of chimney on it; while broadside-on, the difficulty of seeing her was increased by the bow wave. She seemed to cut her way like a plough, banking up the water on each side as it rolled over the snout—to hide herself, as it were, in the furrow between. Suddenly two thin jets of water were seen to rise from the bows, to fall again in showers of spray. This was due to the opening of the torpedo tube-door, and in action would have marked the dispatch of her formidable weapon. As the said door is opened, the water rushing in, drives out the air with the effect just mentioned, which, to uninitiated eyes, would bring confirmation of a previous idea that a whale was in sight; from its resemblance to the action of one of those animals spouting. After this attack, a trial was made of speed against the current. The *Nordenfelt* proceeded very steadily ahead, doing her 8 knots over the ground easily against the full strength of the Bosphorus current, which proved her to possess a speed of something over 12 knots—a very satisfactory result, considering that she was only designed to steam 10. On her return to Seraglio Point, the Sultan desired that a second attack should be made upon the steamer previously mentioned. The funnel having been lowered, the *Nordenfelt* proceeded ahead, gradually sinking as the ballast tank was filled to reduce the buoyancy. On reaching the steamer she was suddenly lost to view, but shortly afterwards came steaming round from the other side. She was supposed to have launched her weapon under water, and then, changing course, risen in another direction in order to facilitate escape in case of a mine. His Imperial Majesty expressed his great satisfaction with the performance of the boat after this run and then ordered her to return to the dockyard.

"Before concluding, it is as well to point out that, although the boat was lying under banked fires, the reserve steam was quite ready, the water in the reservoir having been heated up to the necessary degree over night. This is the normal condition in which these boats would be kept in time of war. They can be maintained in this condition of readiness for days together at a very small expense. The loss of heat from radiation is so small, owing to the special arrangements about the boilers and reservoir, that the pressure in 24 hours only falls some 101 lbs., and this is easily regained by the consumption of from 200 to 300 lbs. of fuel. The boat was altogether under way about five hours, during two of which she was manœuvring solely with reserved steam. At the end of the performance 700 lbs of pressure was still left."

Sodium and Aluminium.—The London *Times* describes a recent metallurgical improvement just brought to a successful commercial completion at experimental works erected for that purpose in that city. This is a new process for the production of sodium, and through sodium, of aluminium and magnesium, which are dependent upon it. The process is the invention of Mr. H. Y. Castner, of New York, who has been engaged on it for several years, and who had obtained certain remarkable results in his laboratory there previous to his coming to England, in order to develop the process on a larger and more perfect scale. The effect of the new process will be to place a practically unlimited supply of sodium, aluminium and magnesium, as well as of metallic alloys dependent upon these substances, at the disposal of the various arts and manufactures at one-fourth of the cost at which they have heretofore been available, and thus to greatly cheapen the many articles of commerce and every day use into which they largely enter.

In the process hitherto employed for the manufacture of sodium and potassium, carbonate of soda, charcoal, and lime, in the proportions of 30, 13, and 7, are finally mixed and calcined at a red heat. The compound mixture is afterwards introduced into wrought-iron cylinders and heated to 1,400° centigrade. The alkaline metal is thereby reduced and distilled from the cylinder containing the charge through a small tube provided for the gases and vapors into a condenser. But the quantity of metal recovered by the process is not usually more than 40 per cent. of that contained in the charge, while the wear and tear on the metal cylinders and furnaces employed is estimated as equal to about 25 cents per pound of sodium produced. In the Castner process the operations are carried on in large cast-steel crucibles. The charges consist of caustic soda and a finely ground artificial compound of carbon and iron, which is the reducing agent. The crucibles are first heated in a small furnace at a low temperature, in order to expel the hydrogen from the caustic alkali, and fuse quietly. They are afterwards removed to a larger furnace, where the sodium is reduced at a temperature of 850° centigrade, whereas the old temperature was not less than 1,400° centigrade. While reduction is in progress the vapors and gases pass from the fused mixture through the exit pipe from the cover into the condenser, where the metallic vapors are condensed to metal while the uncondensed gases escape by a small outlet tube. It is a remarkable fact that about 75 tons of fuel have been required hitherto to produce one ton of sodium, whereas by the Castner process not more than 25 tons are required for the same result. The chief item of saving, however, is that of the wear and tear of cylinders and furnaces. The steel crucibles used in Mr. Castner's process show but little wear and tear. It has been calculated by chemical experts that a crucible will stand at least 200 operations, which would represent not more than 2 cents per pound of sodium produced. The wear and tear of furnaces is calculated at 2 cents more, giving for these two items about one-twelfth the expenditure hitherto required. The furnace already at work is capable of producing 120 lbs. of sodium per day, or at the rate of about 16 tons per working year. This is believed to be a larger quantity than any works now in existence are capable of producing. The materials employed in the process are inexpensive. Eight cents' worth of caustic soda is equal to the production of one pound of sodium. The actual cost of production is not more than 18 cents per lb., which will allow of the substance being sold at 25 cents per lb., or $500 per ton.

The Castner process promises to open up large and important fields of usefulness for the expensive and hitherto comparatively little used substances that have sodium as their base. The principal of these is aluminium, which is impervious to the action of the atmosphere, is not affected by acids, and is better adapted than any other material for many artistic and useful purposes, including not only personal decoration, but submarine work, torpedoes, etc. The use of small quantities of aluminium is found to produce remarkable effects on iron and steel. The application of that metal is said to be the distinguishing characteristic of merit of the Mitis castings introduced by Mr. T. Nordenfelt, and alike to iron and to other metals it imparts the essential quantities of tensile strength, luster, and a capacity for resisting oxidation. Many authorities believe on this account that aluminium alloys with steel or copper will provide the highest qualities of metal for ordnance purposes. Cheap sodium, moreover, facilitates the production of chromium, which imparts valuable properties to iron and steel, and the use of which in iron and steel manufacture appears to be limited only by its available extent.